THE JOURNAL OF ENGINEERING EDUCATION

Published monthly (except during July and August) by the Society for the Promotion of Engineering Education

Published under the Supervision of the Publication Committee.
O. J. Ferguson, K. T. Compton, F. L. Bishop, Editor, University of Pittsburgh.
Published at Prince and Lemon Sts., Lancaster, Pa.

Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of August 12, 1912.

New Series
Vol. XXX, No. 10 JUNE, 1940 Subscription Price, $3.00 per year. Single Copies, 50 cents

TABLE OF CONTENTS

Schools for Artisans. O. J. Ferguson, President 831
Report: Progress in Engineering Education, 1938–39 832
Mathematics—A Language. Evan Thomas 842
Comprehensive Examinations in Electrical Engineering at The Ohio State University. H. W. Bibber 848
Training Engineers to Handle Men. M. H. Clark 855
Accuracies of Different Types of Examination Questions. A. G. Conrad and J. W. Koopman 860
Teaching Lubrication. L. J. Bradford 870
Civil Engineering Page 887
Engineering Economy Page 890
English Notes 893
Mechanical Engineering Page 898
T-Square Page 902
New Members 904
College Notes 906
The Engineering Societies Library 907
Sections and Branches:
Allegheny 908
Michigan 909
Ohio 909
Pacific Northwest 910
Rocky Mountain 911
Necrology:
Lewis Van Carpenter 913
Henry H. Norris 913
Book Reviews 914
Index, 1939–40 917

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SCHOOLS FOR ARTISANS

By O. J. FERGUSON

President of the Society

One of the major embarrassments confronting engineering education today is the presumption based upon experience of the past that it will continue to prepare for industry a large number of semi-trained men to do the work of the artisan and the mechanic. Not that industry desires to have semi-skilled men. It would rather have skilled artisans. But our common agencies for schooling young men operate upon a plan laid out for the sometime professional man, and the culls and low-grade finishers are diverted into the manual occupations and those which do not demand great mental acumen and resourcefulness.

To be sure, our catalogs do not advertise the fact that our students are not all to become engineers. We rather scurry to cover upon this point and shade our heads against the scorching heat of the noontime sun of clear thinking. But the fact remains that lack of success in an engineering course of study is almost a sure directrix or guide into sub-professional work in technical or near-technical lines.

So insidious has this practice been that we have come to speak of it as constituting "an outlet" for our low-standard students. Rather, it is a relief to us! Look, for a moment at the situation.

Industry is not well served by this type of individual, nor by this kind of training. Neither is the sub-grade student well served by the sort of schooling he gets. When he finishes his exposure to class work he is neither fish nor fowl—neither professional nor artisan. He is simply sub-professional in both ability and training.

We should have *schools for artisans,* giving brief but well organized terminal courses that meet the measure of the abilities and ambitions of those who cannot or do not wish to fulfill the exactions of professional training. We should have *many* such schools. Their curricula should be as definitely *planned* for their purposes as are our four-year courses for engineers.

Two very desirable ends would be attained by the erection of such schools. Industry and trade would get what they wish to have by way of a suitable successor to the old-time journeyman. And the colleges would be relieved of the anomaly of using the same courses of training for two widely different products. We might pass on to more competent hands and methods that part of the job which is ours only by sufferance. We could concentrate upon our own tasks, with better results.

But, how can these schools be set up and multiplied?

And how shall we separate our streams of entering students?

REPORT: PROGRESS IN ENGINEERING EDUCATION
1939

Society for the Promotion of Engineering Education

Note: This fifth annual Progress Report continues the record of significant trends, developments and events in engineering education. Former reports appeared in February 1936, April 1937, June 1938 and May 1939.

Earlier reports have at times reviewed the Society's normal activities, evaluated its convention, recorded interesting news and supplied references to papers on notable topics. Worth while as it may be to review and integrate our multifarious activities and to attempt a topical index, considerations of both quantity and quality have made "evidence of progress" the criterion in selection. A member of the committee observes, "Progress is difficult to find and to identify when found."

Appreciation is conveyed to contributors who have again so generously expressed their views which in condensation furnish the tone and spirit of the report, even if not actually quoted.

ITEMS IN THE REPORT

Introductory
Report: Aims and Scope of Engineering Curricula
Engineering and Social Progress
E. C. P. D. Accrediting
Past Year
Next Stage
One Serious Problem
By-Products
Accrediting of Special Curricula
Report: Status and Trends
Report: The Teaching of English
Bibliography: Instructional Methods
Civil Engineering Library List
Conferences at Annual Meeting
Program and Reports
Enrollment Trends
Distribution of Undergraduates
Increase in Mechanical group
In specialized curricula
Mineral Technology
Departmental and Educational Items
Chemical Engineering
Physics
Aeronautics
Summer Conferences
Hydraulics and Fluid Mechanics
Mathematical Adjustments
Engineering Economy Page
Junior Colleges
High School Mathematics
High School Students
Technical Institutes
Libraries
Research in Europe
The War in Europe; Refugees
Armour and Lewis Institutes
Northwestern Technological Institute
New Buildings
Endowed Institutions; Problem of finding Funds and Students

INTRODUCTORY

Progress is the normal condition in a Society for "Promotion." During half of the years of recent decades it has been undergoing self-initiated "Study" and "Investigation" of Engineering Education. Following their findings we are "doing something about

it." In the six years (since the Ithaca convention) membership has increased 35 per cent; conventions have increased in attendance and vigor; conferences at conventions are pioneering and stimulating; the nine "Divisions" of the Society, its nineteen geographical Sections and seventeen local branches, its twenty-seven committees and twelve affiliations with other groups equip it for action on a wide front; accrediting of curricula is raising quality.

Letters to the Committee show keen interest in selection of freshmen, in local curricula, facilities and methods. Topics *re* curricula include—scrutiny of traditional objects and content; liberalize, balance, coördinate; resist "fads" and techniques; basic science and fundamentals; "general engineering"; special evening courses, e.g., metals.

Items deemed significant by some three score of those concerned with engineering education, principally officers and chairman of groups in S. P. E. E., have through selection and condensation from a hundred pages and more, yielded what follows.

Aims and Scope of Engineering Curricula

A significant document has been produced by a committee appointed at the 1939 Convention of which Dean H. P. Hammond is Chairman. The committee presents the new conditions, trends and attitudes which necessitate a new study of engineering education, it specifies objectives and indicates the first steps in implementation toward the ends sought. The report sets forth the views of a large and representative committee on trends and current proposals in engineering education including (*a*) the lengthening of the undergraduate curriculum to five or six years, (*b*) requirement of a period of preliminary study in a school of liberal arts preceding admission to the school of engineering, and (*c*) the trend in the direction of dividing the curriculum in the junior and senior stages. The committee recognizes that engineering colleges serve diverse functions and prepare men for a wide range of technical, administrative and executive responsibilities (Mar. '39, p. 555).* Reprints are available at the office of the Secretary.

Engineering and Social Progress

The foregoing was the title of the presidential address of retiring President Compton at the Annual Meeting. It was followed by "Social Responsibility of the Engineer" by President Doherty (Sept. '39, pp. 18 and 27). Then "The Humanistic Band in the Engineering Curriculum" was presented by President Wickenden (Nov. '39, p. 206). Dean Hammond's Committee on Aims and Scope of Engineering Curricula designates "Humanistic-Social" studies as

* Reference to Journal of Engineering Education.

essential to a rounded educational growth which will continue into professional life (Mar. '40, p. 563).

The E. C. P. D. Accrediting Program

The past year brought to completion the second stage in the accrediting program of the Committee on Engineering Schools of Engineers' Council for Professional Development. The first stage had to do with organizing the program of inspection and developing principles and procedures. The second stage involved carrying these plans into operation. We now have an essentially complete list of accredited curricula of the engineering schools of the country (Jan. '40, p. 463).

The next stage will involve the development of suitable procedures for the maintenance of accrediting on an up to date and satisfactory basis. Three features are auspicious—the extraordinarily fine spirit in which the institutions and the personnel of the committee have responded; second, the large degree of support by the heads of institutions in response to the proposal for the financing necessary for visits of inspection to maintain the accredited list; third, the fine esprit de corps in the committee and the fortunate selection of the new chairman and the additional members to succeed those whose terms have been completed.

The one serious problem is the attitude on the part of the Association of Land Grant Colleges and the Association of State Universities with reference to accrediting in general. In fact, the growing rebellion against the present duplication and vagaries of accreditation indicate the need for systematic and expert review of the entire ideology of accreditation. The rapid extension of accrediting procedures to an increasing variety of departmental activities in an institution entails a considerable amount of effort, expense and annoyance. The committee appointed by the organizations to study the matter has been broadminded and coöperative in its attitude. The relationship between the E. C. P. D. program and that committee is apparently established on a thoroughly satisfactory basis. Our accrediting procedure was made necessary by the State Licensing Laws which, if for no other reason, takes it out of the category of unjustified meddling in the internal affairs of educational institutions. We should be broadminded in our own attitude and coöperative in efforts to bring about a satisfactory adjustment of the entire situation. We must take care lest in the increasing routine character of the work of our committee we fall into the rut of a formalized procedure instead of keeping continually in mind our original ideal of accrediting on the basis of overall excellence without designation of details which should be left to each institution.

An Important By-product of Accrediting is the opportunity to assist institutions to improve their engineering educational programs. Such opportunities arising in all institutions from the best to the poorest have been taken advantage of and have brought commendation from the administrative officers. This service should be continued in an entirely helpful, and in no sense, dictatorial manner.

The foregoing summarizes a statement by President Compton, retiring chairman of the Committee on Engineering Schools.

Accrediting of "Special" Curricula in such fields as sanitary and aeronautical engineering is contrary to the trend toward broad fundamental training; furthermore, prospective students may infer that training for the special fields is to be found only in the few institutions which offer the specialized curricula. Civil, mechanical, electrical, mining and metallurgical, chemical and general engineering include 84 per cent of the accredited curricula; the remaining 16 per cent include some twenty fields of specialization. (Foregoing comment by Dean Morris, Chairman of the Committee on Engineering Education of Am. Soc. C. E.)

It may be noted that accreditable "specialized" curricula are *de facto* being offered. In Aeronautics over 3,000 are enrolled ranging from nearly 1,000 freshmen to over 500 seniors; twelve curricula have been accredited. A condition as well as a theory confronts us.

Status and Trends

Present Status and Trends of Engineering Education in the United States, by Dugald C. Jackson is a pamphlet report of 180 pages based upon the comprehensive data acquired in the accrediting of curricula by the Committee on Engineering Schools of the Engineers' Council for Professional Development. It contains historical summaries as well as treatment of new data. Professor Jackson summarized part of the report in a paper on Trends in Engineering Education (Oct. '39, p. 138). A review of the Report listing the notable items which it contains appeared later (Jan. '40, p. 540).

Report on English

The Teaching of English in engineering schools has been studied by a committee of which President Edward C. Elliott has been Chairman. This report has appeared in monthly chapters in issues of Journal of Engineering Education, beginning in April 1939 and ending with "Conclusions and Recommendations" in April 1940. It is to be consolidated into a single book for general distribution.

Bibliography: Instructional Methods

A Bibliography disclosing 116 articles in 10,000 pages of our publications during the past dozen years is the product of the Committee on Instructional Methods in its endeavor to discover what is most needful of attention next. Possibly its best service is the example it sets for other committees to go and do likewise and thus to make the great mass of our accumulated wealth available through the guidance of those who are experts in our several fields (May '40, p. 761).

A Civil Engineering Library List prepared by the Committee on Library Facilities of the Civil Engineering Division of the Society was distributed in June, 1939. The list of about 775 books has 51 subdivisions.

Conferences at Annual Meeting

Conferences by nearly a score of groups at the Pennsylvania State meeting accounted for over half of the program and probably a still larger part of our banner attendance of over 1,600. Papers which come to the teacher's desk faster than he can read them usually have failures deleted; he is ready at the end of the year to enjoy free discussion of successes and failures too.

Conferences have been successful since the Cornell meeting in 1934 as the time was ripe for them—in the growing consciousness that the curriculum is an integrated whole. When a course does not stand alone but is an integral part of a curriculum, its treatment is of the greatest importance. When instructors are to justify the subject matter and the time required by their courses they appreciate the assistance of course and subject matter conferences.

Dean Case, after noting the foregoing points concludes, "The principles which the student should master as working tools should be the frame work of a curriculum and the primary purpose of instructing students in these principles should be to put them into their minds so as to be retained and used for this purpose. There are many problems to be solved before courses can be so coördinated and administered that this result is assured, but as conference chairman last year, I became convinced, as I watched programs develop and listened to discussions in the conferences I visited, that through the medium of these conferences we are making steady progress in isolating these problems and finding solution for them."

The Program of Conferences (Sept. '39, p. 46) and Reports of 14 of the 18 Conferences (Oct '39, p. 106) are followed by other Reports, by papers and discussions, aggregating 287 pages in eight issues of

ENGINEERING EDUCATION. (Papers at the general sessions of the Annual Meeting take about 100 pages.) The word "Teaching" occurs in 28 of the Conference topics; this and similar titles indicate the pedagogical interest in the discussions.

ENROLLMENT TRENDS

The January 1940 JOURNAL OF ENGINEERING EDUCATION reported the undergraduate engineering enrollment in 146 schools in the United States and Canada as 105,892. In 122 institutions it was 87,284 as compared with 79,403 for the *same* institutions in 1938–39 and 73,945 in 1937–38. In 1936–37 the enrollment in 118 institutions was given as 67,569. This indicates an increase in undergraduate enrollment of nearly 30 per cent in three years. During the same period, candidates for the Master's degree increased from 2,122 to 4,731, and for the Doctor's degree from 369 to 854, both more than double.

Undergraduate increase is presumably due partly to the employment situation but mainly to the growing regard for engineering training as a preparation for careers in industry, business and public service.

The increase in graduate enrollment, particularly for the Doctor's degree, is more difficult to explain, since most industries are interested in engineers with advanced degrees only for posts in their research and design divisions—not for production, construction, operation and sales. The doctorate for prospective teachers of basic engineering subjects may be a factor.

The distribution of undergraduates among the principal curricula in 1939–40 was as follows (with increase in 3 years); Mechanical 124,891 (89 per cent), Electrical 15,860 (47 per cent), Chemical 15,268 (49 per cent), Civil 11,091 (44 per cent), Mining and Metallurgy 4,525 (90 per cent). Of the total in these five groups the Mechanical constitute 35 per cent, the Electrical 22 per cent, the Chemical 21 per cent, the Civil 16 per cent, and the Mining and Metallurgical 6 per cent. These five groups contain two-thirds of the total enrollment of 105,892, and 87 per cent of the 81,958 remaining when the "Unclassified" are eliminated.

The increase in Mechanical Engineering enrollment may be traced to the character of this curriculum and to the recent publicity given to aeronautics, Diesel engines and air conditioning. Most Mechanical Engineering curricula stress management and labor problems, which may be an added explanation.

For a while too many with insufficient aptitude for scientific studies were attracted to Chemical Engineering. To the credit of the teachers and particularly to the American Institute of

Chemical Engineers, the increase in enrollment is now comparable with the increase in Electrical and Civil Engineering.

Curricula in aeronautical, agricultural, architectural and other specialized branches do not attract many students (about 5 per cent; with aeronautical predominating). Neither is the popularity of curricula in general, administrative, and industrial engineering as great as some have predicted. These facts are added arguments against curricula which are too specialized or which endeavor to combine engineering and commerce in one four-year program of study.

The continued growth of enrollments is a definite indication of public approval of engineering education, a public trust which increases the responsibility of engineering teachers to maintain standards of quality. (By Dean Potter, incoming Chairman, Committee on Engineering Schools, E. C. P. D.)

In Mineral Technology the undergraduate enrollment in the 53 schools of the United States in 1938–39 was 9,619, an increase of 34 per cent in two years; principal groups—petroleum and natural gas, 37 per cent; metallurgy 25 per cent; mining 20 per cent; geology 8.8 per cent; ceramics 8.6 per cent. Graduate students in 1938–39 were 415, an increase of 23 per cent in two years. (Prof. W. B. Plank in *Mining and Metallurgy,* June 1939.)

Departmental and Educational Items

Chemical Engineering. Perhaps the most notable trend has been the intensified application of mathematical analysis to the so-called "unit operations,"* such as heat transfer, fluid flow, drying, evaporation, distillation, etc. Begun at M. I. T. under Walker, Lewis and McAdams, their first outstanding textbook, 1923, has exerted a powerful influence. In a decade a new generation, trained in the quantitative approach to chemical engineering problems, began to make themselves felt; the whole field is now being re-worked, using new data. New textbooks and monographs add to progress, but they are still too few.

"Instruction has greatly improved. It has taken nearly forty years to get the teaching into the hands of qualified chemical engineers and to provide adequate physical facilities for instruction. The old idea of chemical engineering as wash-tub chemistry still lingers in a few schools.

"To sum up, then, there are many indications that chemical engineering is maturing rapidly, it is becoming more and more a mathematical, a quantitative kind of engineering; its technical

* The word "Unit" occurs in 8 of the 11 topics on the program of the Chemical Engineering Conference.

literature is growing; the quality of instruction and the physical facilities of the schools are improving; a younger generation is putting it across at last; the older generation which no longer knows enough to teach chemical engineering is being retired to the cheering section or, in a few instances, to deanships." (From Dean Harry A. Curtis.)

Physics. The Chairman of the Physics Committee, Professor Grantham, notes the following conditions and trends relating to engineering. A demand for increased hours in physics to equip the development engineer for applying the new physics to industry, effected by placing the introductory course in the freshman and sophomore years and more advanced special topics in smaller groups in the upper class years. Recent developments in engineering indicate a much shorter time-gap between discovery by the research physicist and its application to industry. A survey of the physics courses for engineering students in sixteen leading European technical schools reveals that those schools are far in advance of American Engineering schools in the amount of modern physics presented to their students.

Aeronautics. Coöperation with the Civil Aeronautics Authority "has been going fine" is reported by several institutions; elsewhere curricula have been inaugurated to meet the demand for engineers and production men in the industry; *e.g.,* University of Michigan and Polytechnic Institute of Brooklyn.

Summer Conferences. The Surveying and Geodesy committee of the Civil Engineering Division conducts annual conferences which are elevating the status of surveying and the quality of instructors.

At the University of New Hampshire Dean Case is sponsoring a second conference; this one to deal with the problem of building up curricula to meet modern needs.

Hydraulics and Fluid Mechanics have advanced in technique of teaching and in subject matter, as noted by comparison of recent and older graduates visited on a coast to coast trip. Both teachers and texts have improved.

Mathematical Adjustments result from conferences of teachers to find what mathematics will best meet the needs in future engineering courses. Likewise, mathematics and physics teachers are together developing new viewpoints and new courses. (Such practices unfortunately are presented as notable, rather than traditional procedure.)

The monthly Engineering Economy Page notes confusion of thought on fundamentals, confuting the assertion that students can understand it without studying it. Some advocate a separate course rather than inclusion in engineering technology.

The Junior Colleges are finding that the first years of engineering education, even though the subjects be mathematics, English, chemistry or physics, must be given with an engineering accent if they are to serve as a foundation for engineering courses, and that giving instruction in this way is expensive. Inadequate junior colleges are dropping pre-engineering courses while there is strengthening of work in the larger ones.

High School Mathematics is taught in many engineering colleges in the Middle West because of deficiencies of entering students. Some college departments of mathematics are attempting to put into the secondary schools a better prepared teaching personnel.

High School Students contemplating engineering should be urged to study mathematics, literature, history and English, and omit manual training, mechanical drawing, bookkeeping and the like, now often recommended. If interest in reading is not developed before a boy is fifteen it will be hard to interest him in social sciences in college and in the later self-development program proposed by E. C. P. D.

The Technical Institute giving a short—usually a two-year—course was accorded a worthy place in the educational-industrial program by a Study made in connection with the Investigation of Engineering Education a decade ago. There is now an awakening interest to meet a real need. "Every other phase of education has been developed at public expense." To meet local demand Oklahoma A. and M. College has created a School of Technical Training with two-year curriculum.

Libraries. H. W. Craver, Director of Engineering Societies Library, notes a growing appreciation of the value of libraries; letters that come to him indicate that students are studying the literature rather than one textbook. This seems to be arousing an effort to improve libraries of engineering schools, which are not as well supported as those of other colleges. A worthwhile study might well be made of facilities offered, both in book resources and in training of students in their use. The latter is usually done by the local librarian; books and pamphlets are available.

Research. An English scientific journal states that prior to 1933 over half of new process and new product development came from Central Europe; in 1938 less than five per cent. Totalitarian influence on education is forcing American industry to a new dependence on research "Made in U. S. A."

The War in Europe may have an important influence here in the transplanting of refugee scholars.

Armour and Lewis Institutes have agreed to merge into the

Illinois Institute of Technology, subject to Court permission. Plans have been made for the combination of the two schools on a single campus. This consolidation may be a forerunner of a movement toward coöperation and combination, since other comparable situations exist elsewhere.

Northwestern Technological Institute, made possible by a gift of $6,735,000, expects that the fall of 1941 will bring completion of its great building—the architect's drawing follows the general scheme of the building at Cambridge. Curricula will be offered in chemical, civil, electrical and mechanical engineering on the five-year coöperative plan. The "quarter system" will begin in the fall of 1940. The Northwestern Institute of Technology as conceived will afford a gauge of a number of issues: (1) The relative merits of the coöperative plan in engineering education at the present stage of development; (2) the residual need in engineering education that will permit the creation of a new institution in competition with those now existing; (3) the ability of such an endowed institution to compete with strong state universities which have heretofore served this area.

New Buildings. The notable expansion of engineering buildings at the publicly supported institutions under federal grants is an important development. The effort to maintain the buildings and to fill them with students may result in a further divergence of standards between institutions with limited enrollments and high degree selectivity in admissions and those politically supported which have many incentives to multiply enrollments.

Endowed Institutions with limited resources and dependent largely on student fees for operating funds may have difficulty in filling their rosters with suitable students in the face of competition from low-tuition publicly supported institutions. This question is one to which engineering education may well address itself at this time.

F. C. Bolton,
R. E. Doherty,
C. E. MacQuigg,
C. C. Williams,
C. F. Scott, *Chairman.*

MATHEMATICS—A LANGUAGE

By EVAN THOMAS

Emeritus Professor, University of Vermont

I

At the meeting of the Society at State College, a forum was held on the interrelation of mathematics and mechanics. Papers were read by Professors Glen N. Cox, Louisiana State University, N. C. Riggs, Carnegie Institute of Technology, and Tomlinson Fort, Lehigh University. More than ordinary significance attached to these papers by reason of the eminence of the writers in the field of engineering education, their active interest in teaching as well as in research, and their extended and successful experience in the classroom.

A comment from the floor by Professor Switzer of Cornell is of more than passing interest to those engaged in engineering education. It was that an educated engineer is trilingual, expressing himself, according to convenience, verbally, graphically or symbolically. The present paper is concerned principally with the third of these, or the linguistic aspects of mathematics.

II

Mathematics is, among other things, a language, an organ of expression comparable to the vernacular. It has its vocabulary and grammatical constructions, even more precise and exacting than those of everyday speech. In its simplest form, arithmetic, it penetrates all levels of society. According to Josephus, Adam was a natural mathematician, which is one way of saying that mathematics is ingrained in man's nature as a rational being. For the engineer it is the language par excellence, without which he would be hampered in his professional practice if he aspired to pass beyond precedent and to face new problems.

The linguistic aspect of mathematics can be exhibited more clearly by an illustrative example, like $S = 16t^2$, familiar to every reader of high school physics. This is a statement in symbolic language of a well known physical law and is easily translatable into the vernacular. In the algebraic form symbols replace words and the equation the verbal sentence. The economic advantage of the symbolic language for the engineer is obvious. The same in-

formation is implicit in the compact equation as in the diffuse verbal sentence, bearing out the contention that "algebra is one of the greatest labor-saving devices ever invented by the human mind."

The peculiar power of the mathematical language, however, is seen in the search for the hidden contents. If, for example, it is desired to know how far a body will fall in a given number of seconds, the information can be obtained with comparative ease from the equation, even when fractional parts are involved. If it is required to find how long it will take a body to fall a given distance the answer can be found to any desired degree of accuracy by solving for t, while it would be practically impossible to get the same information by verbal reasoning. It is the language in which all extended operations in the exact sciences and technology are carried forward. To the student, mathematics is chiefly, if not wholly, concerned with manipulation and calculation, which makes it incumbent upon the instructor to emphasize the often neglected linguistic phase of the subject.

III

This language, like any other, has to be learned and the sooner the beginning is made the better. The linguistic aspect of mathematics could be approached with advantage much earlier than is now customary, even with number work itself. To the pupil this work has to do with calculation alone and the object is to get the correct answer. The linguistic idea does not come into his mind at this stage but will dawn later under the tuition of a resourceful teacher, who will provide drill not only in counting but also in methods of expressing the result of counting.

The teacher puts on the table three objects (say pennies for psychological reasons) and asks how many. After the prompt answer "three" the teacher can suggest that the answer can be given in writing on the blackboard in three ways: the word "three," three strokes, and the arabic 3. Then eight pennies are used and the question repeated. The pupils will now hesitate and the teacher will suggest counting (solving). This done, the previous board work is repeated. Finally a considerable number of coins will be thrown on the table and the pupils are again asked how many. Following the prompt "I don't know" the teacher will put "I don't know" for "three" or "eight" and x for 3 or 8, omitting in this case any attempt at graphic representation.

This process will be for some time quite meaningless except as a matter of memory. As the work advances, however, meaning will dawn. The process should be continuous, letters and simple equational forms being judiciously and progressively used through-

out the arithmetical course. In this way the present sharp line of demarcation between arithmetic and algebra will disappear, greatly to the advantage of the pupil's future course. A firm foundation will have been laid without the pupil's knowledge for subsequent algebraic studies.

IV

Thus far we have dealt largely with vocabulary and equational forms so elementary that the significance of their linguistic element has been hardly recognizable. This element comes more clearly into view in problem work of first year algebra. The first step here is essentially linguistic, the translation of the verbal statement of the problem in the book into a symbolic statement in the form of an algebraic equation. The second step is the solution of this equation, which is, like the first step, in essence a linguistic process, consisting of operations upon symbols which have the same meaning as the corresponding words in the verbal statement.

In current practice more attention is given to the second than to the first step. The real objective is the answer obtained by solving the equation. The preparation of the "statement," or the translation, is treated as a preliminary to the solution. Aid is given more readily by the instructor in setting up the equation than in the subsequent solution, and failure in the former does not count so heavily as failure in the latter.

This is regrettable. The second step is the easier of the two, being largely a routine matter for which definite rules are given and should offer no serious difficulty to any student of sufficient mentality to take algebra.

With the first it is very different. There are no formulated rules for the preparation of the "statement." The student must think his way through, aided, of course, when necessary by a judicious suggestion from the instructor. The absence of set rules and the demand for independent thinking give to the first step the more educative value, and the instructor should not fail to impress upon the mind of the student that ability to set up an equation is a mathematical attainment of a much higher order than ability to solve the equation once set up.

V

Analytical geometry, "the poetry of mathematics," is, like all poetry, highly linguistic. The initial step is of this sort. The verbal statement of the law governing the movement of the generating element is translated into an equation. This, in turn, may be translated, by plotting, into graphic language. The same geo-

metric idea is expressed in these three mediums of speech in which the engineer may convey his thoughts. The reasoning is carried on by operating upon symbols and not in words as in Euclidean geometry.

An effective introduction to calculus would consist of a drill in translating into equations of the problems in the chapter on rates in any standard text in advance of the customary sections on limits, infinitesimals and so on. This would help to acquaint the student with the characteristic features of the problems to the solution of which the methods of the calculus are applicable, furnish a glimpse of "what it is all about," and provide some insight into its utilitarian aspects, all of which are calculated to awaken interest and stimulate effort. Work along this line could be begun advantageously with the section entitled variation in algebra, a section which should be given a much more important place than is customarily assigned to it.

An alert instructor will find in this translational work many opportunities to prepare the mind of the student for an understanding of the root concepts of the calculus, such as the differential and the differential coefficient. A study of related variables, thrown into equations, leads to the idea of a rate of change, and this upon further examination to that of an instantaneous rate of change which can be verbally described in terms of an ordinary arithmetical fraction. The verbal definition can now be translated into the conventional symbolic form. A firm grasp of this symbol as a compact description of an important physical phenomenon is a good preparation for the study of its algebraic derivation in terms of increments and limits, a process liable to be somewhat misty to the beginner.

At this stage a few simple rate problems could be profitably solved in advance of any effort to derive the rules for differentiation. This would provide a good background for the study of the processes involved in the formulation of the rules.

VI

The linguistic element in mathematics is seen in the coöperation between the mathematical and the technical departments, for which Professor Fort made a strong plea. The problems invented by the mathematician, most of them interesting and many of them important, and those arising out of the practical needs of the engineer are alike in fundamental principles but may differ widely in application. By the proposed coöperation mathematicians and engineers come to a better understanding of each other's interests and a keener appreciation of mutual helpfulness.

To the mathematician 2, 3.8, .07, x, y, z are materials out of which he erects a structure of reasoned abstract thought. To the engineer these same symbols have a more marked linguistic significance. They are not taken separately but in association with length, area, volume, weight, and countless quantitative relations of the material things with which the engineer has to deal. Any combination in an equation is a description in symbolic language of the behavior of things of touch and sight. The differential coefficient is not merely an algebraic symbol but a very ingenious description of the behavior of such bodies as rotating cylinders and vibrating strings. The engineer sees in the integral a measure in compact and perspicuous language of the accumulated effects of a variable force acting through an assigned interval of time or distance.

Through this coöperation the student is protected in a large measure from the impression that a mathematical expression is a jumble of symbols and that an algebraic transformation is a process of juggling with symbols, possible and of interest only to the few who have a "head for mathematics." In algebraic transformation is seen a process of reasoning not unlike, as a form of mental activity, a train of reasoning conducted in the vernacular.

VII

Mathematics as an organ of expression and an art of calculation is an essential part of the equipment of the educated engineer. It is unfortunate that there is among engineers of high standing a habit of referring, often contemptuously, to mathematics as a "tool," a term more suggestive of the hammers and chisels of the artisan than of the intellectual accomplishment of a member of a learned profession. This assignment of a mental and relatively unimportant rôle to mathematics in engineering practice operates injuriously upon the student's application to the subject and his work in these technical branches dependent upon mathematics.

Mathematics is a tool but in a higher and more comprehensive sense than what B. G. Lamme had in mind when he wrote: "Mathematics forms the tools of the profession, and, like all tools, should be put out of sight before the finished product is exhibited." To Lamme's great teacher, Professor Stillman W. Robinson of Ohio State University, mathematics is of two kinds: gymnastics and horse sense, the latter sufficing to solve nearly all the problems of the engineer. Even a non-engineer, the eminent psychologist, J. McKean Cattell, once wrote: "Perhaps we all should know how to use a tool as fine as the calculus." These views are at the opposite extreme from Kummer's classical boast that his specialty (theory

of numbers) was the only branch of mathematics not yet sullied by contact with applications.

The utility of mathematics is unquestionable, but to say that mathematics is useful is not the same as to say it is a tool. To the engineer a handbook may be thought of as a tool but it would be most incongruous to speak of Clerk Maxwell as handling a tool when he was translating into equations the results of Faraday's experimental work. It is, of course, too much to expect of even the educated engineer anything comparable to Maxwell's fluency and copious diction in the use of symbolic language, but it is not too much to expect that the educated engineer shall be more than an expert in the use of handbooks. He should certainly be familiar with differential and integral notation and have some understanding of the corresponding processes. Without these he would be a stranger in the ever expanding fields of physical science and technology. The books and the memoirs of the masters will be inaccessible to him and he will hardly be at home on the higher levels of professional practice.

COMPREHENSIVE EXAMINATIONS IN ELECTRICAL ENGINEERING AT THE OHIO STATE UNIVERSITY *

By HAROLD W. BIBBER

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Introduction

Comprehensive examinations, according to a strict definition of the term, have been employed thus far in the Department of Electrical Engineering at the Ohio State University: (1) for graduate students who are candidates for the Master's degree and the Doctorate, (2) for honors group students in the junior and senior years of the electrical engineering curriculum, and (3) for senior students taking an optional course in electric power generation, transmission, and distribution.

Comprehensive Examinations for Graduate Students

The comprehensive examinations given candidates for the Master's degree are in oral form. This is the only general examination at present required. For the Doctorate, written general examinations in the principal fields are required, but a general oral examination of a comprehensive character is also administered. There is no rigid requirement that every question put to the candidates by members of the examining jury should be comprehensive in character and not all are. The main purpose of the oral examinations at these levels is to determine the degree of integration of the several subjects which have made up a student's program, in particular: theory of electricity, mechanics, thermodynamics, radiation, and mathematics.

The students are advised to prepare themselves in the fundamentals of these subjects so that they will be able to analyze, and to some extent to synthesize, idealized physical situations. We attempt to construct as original questions as possible which are not to be found in any textbook, course, or notes. With this end in view it is customary to have present on the examining jury, members of the staff who have not had the candidate in any course

* Presented at the 47th Annual Meeting, S. P. E. E., Pennsylvania State College, June 19–23, 1939.

work and who are, to a considerable extent, in the category of outside, independent examiners. The student is sent to the blackboard for a large part of the two hour period. Most of the questions involve an analysis or synthesis of a physical situation in terms of the calculus or vector analysis. A question involving mechanics, electricity and mathematics may be followed by one dealing with wave motion in hydro-dynamics, and this followed by another dealing with the relationship of heat dissipation, vibration, and magnetic flux density in the stator of an induction motor. Very frequently questions from the engineering group of examiners represent simplifications of problems that they have encountered recently in their consulting work.

At least one practice session is arranged for each graduate student before he takes the oral examination that is graded and on the basis of which he is approved either for the M.S. degree or for admission to candidacy for the Ph.D. Before we started practice sessions there had been occasional failures in the examination of men whose course work had been entirely satisfactory. Even now at rare intervals there are men who are emotionally disturbed by the situation they confront at an oral examination with outsiders present.

Collective discussion among graduate students is promoted by requiring oral examinations. Our students have been provided with a room having a blackboard, a large table, and plenty of chairs to encourage such sessions. Apparently many students get pleasure from trying to "stick" their fellow students with difficult questions, and others get satisfaction from showing that they can answer any fair question.

Certainly the oral comprehensive individualizes the examining process to take into account the particular aspects of the electrical engineering field to which a student has been devoting the major part of his attention. It is our feeling that an oral may be made more searching and critical than any written examination. Furthermore it enables a faculty group to judge in some degree the *quality* of a student's mind, as well as its logical functioning and its store of useful facts.

In our experience it seems to be easier to ask students questions in an oral examination that are intended to determine whether they know what facts to look for in connection with a particular question, rather than knowing how to find certain facts which may be assigned to them to run down. At the graduate level we feel that *knowing what to look for* is the essential quality for which to examine.

Comprehensive Examinations for Undergraduate Honors Group Students

In describing to students selected for honors group work the objectives of such work, emphasis is placed on the necessity of a proper use of the time resulting from their freedom from regular class assignments and attendance. They are urged to employ some of their time to integrate their electrical engineering more thoroughly with other fields of study, which it has so far not been feasible to organize on an honors group basis.

Both oral and written comprehensive examinations have been given to honors group students. The method of administration of the orals has been varied. A practice type of oral has been given at the end of each quarter in most years, and this is expected to be continued in the future. At the final oral in May, either for the junior honors men or the senior honors group, we have recently been assigning to each man a week or ten days in advance, a different and rather difficult problem which he is to solve and on which he is to report at the beginning of the oral examination. This seems to work very well. It gives the student the opportunity of consulting the literature as he has been able to do in preparation for the weekly seminars which we now conduct in our honors work.

He can arrange his ideas about the problem after careful thought, and can feel certain of some degree of success with the early part of the oral examination. This apparently puts the student in a better psychological condition to be led off from the problem on which he has prepared into other aspects that are related to it, and to further topics which are not related. Problems for this purpose are similar to those we have used for the written comprehensive examinations for which the use of the library has been permitted. The list of problems that has been handed out to you shows what these are like.

We have been led to make this change recently because we have been studying means for accomplishing the purposes of the comprehensive examination without taking the time which a long written comprehensive requires. With only one-half to two-thirds of the students' work of the "honors" type, and with the necessity of completing some term papers and laboratory notebooks near the end of the academic year, the requirement of a long written type of comprehensive examination has proven very unpopular with our honors group students, and we have received many complaints about the time required to write a neat examination book. We hope this combination of written and oral may be a satisfactory compromise.

In our use of the comprehensive examination for honors group men we have combined in one examination "curricular" compre-

hensives and "course" comprehensives as defined by C. V. Mann in a paper presented at the S. P. E. E. convention at Texas A. and M. in 1938. Our conclusion at this moment is that a comprehensive examination is the only type appropriate to gauge the success of honors group work that has a high degree of integration as one of its principal objectives.

Comprehensive Type Examinations for Undergraduates other than Honors Group Students

To a considerable extent in the electrical engineering curriculum we have pursued the policy of making the final examinations in all courses "field" comprehensive up to the point covered in the field at the time in question. We try to live up to the statement we make to the students that they are never "through" with the content of any electrical engineering course. Our examinations in alternating-current machinery courses regularly involve questions in which there is the use of a calibrated d-c. driving motor or generator. Examinations on transmission line theory involve practically all of the circuit theory, including self and mutual inductance, that has been presented to the student previously.

In an optional course taken on the average by about 40% of our senior students entitled "Generation, Transmission, Distribution, and Utilization of Electric Power," we are able to teach on a very broad basis and to examine comprehensively. It is a "coordinating" course, in which the questions and topics treated cover all phases of electrical theory contained in the curriculum, and in addition: mechanics, strength of materials, machine design, economics, and heat engineering.

The students in this course also receive a laboratory comprehensive in connection with an all-day model power-system test which employs the 16 or 18 students in the class in rotating positions operating an interconnected power system made up of most of the d-c. and a-c. machines, transformers, artificial transmission lines, and load rheostats in our laboratory.

As this represents what is perhaps the most novel contribution that I have to make to our discussion of comprehensive examinations today, I will explain this in some detail. It may not be possible to duplicate this type of examination in many other fields but there may be opportunities of doing so in part. I recount our experiences with that hope.

Laboratory Comprehensive Examination

The objective is to set up a model a-c. power system having one "steam" and one "hydro"-generating station with two generators

each, resulting in a total capacity of 75 kw. There are artificial transmission lines connecting these stations to the loads, and one connecting the stations that is sometimes open. A diagram of the entire system is put in the hands of each student, and a large mimic-bus diagram is also provided for laboratory use. Load is furnished by synchronous motors, a synchronous converter, induction motors, and resistance-reactance banks. One synchronous machine is used as a synchronous condenser to maintain voltage by correcting power factor at a location designated as a receiving sub-station.

Predicted load schedules, each different, are issued a week in advance of the test-day to members of the class. Each student acts as load dispatcher for the particular day shown on his load schedule. These dates cover most of the year, one or two being chosen from each month. Based on the steam turbine economy curves, water-storage data and hydraulic turbine efficiencies which have been given to the students previously, they determine the manner of operating the generators for greatest economy for the expected load curves that they have been given. These results are checked in advance by the instructor, and constitute a review of work in an engineering economy course.

Load schedules are distributed to the various load stations at the start of each run during the day of the test, and it is the duty of the men in those stations to follow the load schedule exactly, the scale being one minute of the test equals one hour of the schedule for a day. The total load or sum of the individual load graphs handed to students at the load positions for a given run follows the general trend of the predicted curves given out in advance, but there is always some rather marked variation or emergency which has been inserted during the 24 minute day, which the student acting as load dispatcher has to face, and modify his plan accordingly.

It is also his duty to check and give orders for the operation of the two generating stations and the synchronous condenser receiving substation while he is in charge, so that constant voltage at a specified point will be maintained and both instantaneous and integrated frequency kept as near 60 cycle values as possible.

It has been found convenient in operating this system to start each run in synchronism with the main 60 cycle power system of the laboratory and as soon as all induction and synchronous motors have been started and are running with enough generating capacity operating to supply all load on the system, the connection to the 60 cycle power supply of the laboratory is cut off and the driving power for the system comes through the d-c. motors driving the generators. Both pairs of generators have salient-poles, but one pair is not provided with amortisseur windings. This gives the

students some new experience as well as testing their knowledge of the function of such windings.

During every run there is some emergency such as a sudden thunder shower on a summer day or the loss of a transmission line during a winter day so that a student's ability to see the system in terms of the mimic-bus and wiring diagram that is set before him, and his ability to issue orders over the telephone system, shows both his knowledge and also his ability to make that knowledge function effectively in a situation simulating actual practice.

Two members of the department staff observe the action of students in the different positions and make notes regarding each of them during the day of the test. At the start the skill of students in wiring up all types of a-c. and d-c. motors and circuits is checked because the tests require the use of nearly every a-c. motor or generator connected to a d-c. machine that we possess, and the use of most of the available positions on the interconnecting board of the power laboratory. Ability of students to modify correctly the speed or torque output of direct-current motors, to synchronize under rather complicated conditions, to parallel two synchronous generators on the same bus, and to parallel one station separated from another by appreciable reactance, are all tested.

The student must show a knowledge of the principles of: shift of wattless load with change in a-c. generator field excitation, synchronous motor power factor, induction motor performance, and induction generator performance.

The course work for several weeks preceding this comprehensive laboratory test bears on the theory of interconnection and system operation with respect to machines out of service, when a machine is to be brought in, etc.

Experience with this test, as might be expected, is that through poor manipulation, synchronism is lost on some of the runs. Then all switches are pulled, the connections to the 60 cycle laboratory power supply again closed, a-c. motors are started, the generators synchronized, load picked up, the laboratory power supply disconnected, and the test resumed at the point where shut-down took place. A log is kept at each generating position, and another by the assistant load dispatcher.

The closing class sessions are devoted to a clinic which is in the nature of oral examination of the students as to certain problems which arose during the test set-up and how they should have been solved. It would be preferable educationally to have everyone stop working at the time these arise and to discuss them at that moment, but the fact that the set-up cannot be left connected more than two days, and the length of time required to rotate each man through all positions makes it impossible to do this.

The grades received by men in this laboratory comprehensive are sometimes very different from those which they receive in the written examinations. As would be expected, many of the more mathematically-minded men are somewhat at sea in the laboratory test, and the more practical minded fellows show up to good advantage. Last year I had one man who had done very well in the class who was also the top ranking man in the laboratory comprehensive. He has gone on with graduate study and is very evidently a gifted individual. The student reaction to this type of laboratory comprehensive is very favorable, many of them expressing themselves as enjoying it more than anything that they have done in our curriculum. They do not object to the extra time or hard work that is involved.

Perhaps I should say one thing further. We do not refer to this all-day laboratory exercise as an examination more than incidentally. The opportunity provided the students to use much that they have learned in two or three years during the course of one day, and the chance to show what they can do in a situation which approximates real engineering practice are the aspects that are stressed.

TRAINING ENGINEERS TO HANDLE MEN *

By MYRON H. CLARK

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It is estimated that less than 20 per cent of the people who are in industry are in that kind of work for which they are best fitted. This may mean that 80 per cent go to their daily work wishing they were in a different vocation. Under these conditions the handling of men cannot approach satisfaction. This situation should be a challenge to the engineer.

The 40,000,000 men and women who work in business in this country may be classified into three groups: 4 per cent are proprietors and salaried officers; 12 per cent are pivotal people—departmental heads, buyers, foremen, etc.; and 84 per cent are the rank and file of men and women workers. In the opinion of many top executives the 4 per cent are the most poorly trained, and the 84 per cent the best trained—for their respective jobs.

The present industrial situation is largely the result of neglect of proper consideration of fundamental principles, due to shortage of leadership in the 4 per cent. Men have been taken for granted while enormous technical developments have taken place.

Durant has stated that more progress has been made along lines of product, process, and equipment in the last generation than had previously been made since the beginning of civilization. We have not made corresponding progress in learning how to live and work together under these new conditions. Shall we ever accomplish this without real leadership?

What is the difference between "leadership" and "executive ability"?

Why does not the best mechanic always make the best leader of the crew?

There is a difference between "lead" and "drive." The latter has probably been too prominent in our thinking, until we have lost the art of leading.

This characteristic of leadership must be in a man first before it can be developed for larger usefulness. "Leader" implies "followers." Hence, to be a leader a man must be worth following. He must have an outward look on life—he cannot be an introvert.

* Presented at the 47th Annual Meeting, S. P. E. E. (Industrial Engineering), at Pennsylvania State College, June 19–23, 1939.

His chief concern, at all times, is the crew—not his own interests. He is concerned, acutely, as to what effect his example is having on the crew. He cheerfully sets such an example, through his daily conduct, thus building confidence upon which alone coöperative effort can be accomplished. He must be open minded.

Such men can be found at the early age of 18 to 20 years, for these qualities show themselves early in life. Seeking such men means that with proper training good leaders will be developed.

Too often in the past the ability to handle men has been taken for granted, or learned entirely by actual experience. Very little thought has been given to learning from the experience of others. This experience, if used, brings out the importance of considering causes back of conditions rather than putting too much emphasis on symptoms.

An engineering school, instead of turning out things, as our factories do, turns out men. The President of one engineering school states that 80 per cent of his graduates go into executive work. The success of this 80 per cent depends to a large extent upon their ability to handle men, and there is a question whether some portion of these should ever have gone into executive work.

The average employer whose engineers go into executive work would welcome having young engineers come to him acquainted with the fundamental principles back of human relations.

To check this, letters were recently sent to 130 executives in industry asking for their reactions. Many replies covered more than one page. The following extracts from a few letters are typical of nearly all of the replies:

"It is my general opinion that engineers are so extremely busy during college getting technical information that they have very little time to absorb Industrial Relations. I believe a very short lecture course might be added which would emphasize the importance of this subject and give them a bibliography for reading as soon as they got into industry. They should also be impressed with the fact that the way to get Industrial Relations is by working and playing with the operators in the plant when they get a job."

"To summarize my beliefs, it seems to me that one thing which technical institutions could do to offset this lack of training is to encourage students to engage in extra-curricular activities as fully as possible, especially those which involve dealing with their fellow students and others in getting things done. In addition to this, I feel that a thoroughgoing course in applied psychology would give students basic knowledge of how human beings react and why, which as a senior subject, would give them some preparation when they get into practical jobs."

"Some training in psychology and in the handling of men should be included in their college courses."

"If the engineer's training is to place him in a position to handle

such problems as outlined, his education, in addition to the purely technical side which it covers at the present time, will have to be broadened by the inclusion of such subjects as Economics and Psychology in his college curriculum."

"As far as my experience goes, no technical graduates are in any way trained to handle personnel problems or to understand fundamental economic problems. I think it is the most important thing for any educational institution to do, and am not aware that any are really attempting it."

"It is a rare exception to find an engineer who can handle men."

"Speaking generally, if engineering schools could instil into their students an appreciation for labor as such, and the realization of the right of every man to command respect in the performance of his work, and that every man, regardless of his station, takes pride in his job, it would appear to me that this understanding and appreciation would be of immense help to the engineer approaching industry in helping him fit into an organization and work well with the men in the plant either in a supervisory capacity or as a staff engineer."

"In the opinion of the writer, if there is one respect in which engineers are lacking it is in their ability to handle men properly. However this lack is not confined to engineers, as it applies to many technically trained individuals. In order to handle men one must be a natural leader. Some courses in human engineering should be given along with regular engineering courses."

"I would hazard this observation, however,—that any training that would make engineers more articulate or improve their self-expression should be beneficial. I have also noticed that engineers are usually so rapt up in their technical knowledge that they often lose sight of the common human contacts that mean so much in good industrial relations."

"I was talking about the subject a few weeks ago with one of our people and we made an experiment. I said that I could, and I was sure that he could, pick out of the whole group of engineers just five men who would or could be selected as engineering managers or section leaders five years hence. It is interesting enough to note that we both went up to our engineering department. I picked five and he picked five and when we came back to the office and compared notes we found that we had picked the same five. On discussing this further we found that we had both picked the same five for the same reasons and they were: these fellows had made an effort to be generally known in the shop; fellows who had made an effort to go out into the shop and get the other fellow's ideas; fellows who did not hesitate to give credit where credit was due; and fellows who were generally liked by those around them. These fellows were also ones who took part in the social activities of others in the plant."

These letters illustrate the thinking of successful executives today. Feeling the need of training for their men, many of these manufacturers are today conducting training programs in their own plants.

Experience shows that engineers, to be successful as leaders,

need to give consideration to certain definite thoughts which can be presented to them in the shape of training programs, either during the school period or later. These thoughts are:

1. The purpose of industry is to serve the public.
2. The interests and issues of management are identical.
3. The same emphasis that has been given to executive development and technical training should be given to training men to handle men.
4. Good Industrial Relations will always be greatly helped by a sound program of compensation after proper selection and placement. At least three basic principles prevail here:
   a. Adequate wages to maintain self respect.
   b. A sound yardstick for measuring each person's productive capacity.
   c. A representative voice in the councils where wage is being determined, so that each man will know why this wage is what it is.
5. On all subjects affecting employees or the men being trained, a complete open book policy should be maintained as to all facts affecting a situation.
6. Job pride is a quality that can be cultivated.
7. If a man is in charge of men, and not interested in men, he is out of place.
8. The first fundamental in sound labor relations is sound and scientific selection of men, especially of the 16 per cent of men in industry who handle the 84 per cent and on whom depends the attitude and morale of the 84 per cent.
9. A man's value to his company is inversely proportional to the amount of supervision he requires.
10. There are at least six basic phases of any man's life and experience which should be carefully checked if he is properly to be considered for handling men. These are:
    a. Character.
    b. Inteligence.
    c. Personality.
    d. Health, and program for maintaining same.
    e. Leadership and work habits.
    f. Background, including both his practical experience and education.
11. Five qualifications for a modern business leader should be kept before the engineer:
    a. The courage and ability to tell the full truth at all times to all parties involved in any situation—sticking to the facts without prejudice.

b. The willingness to consider his own personal example in all walks of life as carrying more weight and influence than anything he says or publishes.

c. Giving at all times the same consideration to the rights of others that in turn he asks for his own—never putting his own interest up for first or chief consideration.

d. Holding no grudges toward anyone and dealing at all times with tolerance toward all persons or groups.

e. Making use of all his possessions of money value and time in the spirit of a steward—considering all such as possessions and their use as a trust.

12. To handle men effectively an engineer must have:
    a. Knowledge of the technique of supervision, in addition to other skills necessary.
    b. Actual ability to use this technique.
    c. Proven ability to handle himself properly under all conditions.
    d. Ability to multiply himself.
13. The marks of a good leader, as against a driver, are as follows:
    a. He overcomes fear.
    b. He is openminded and teachable.
    c. He performs his duties in a pleasant manner.
    d. He is constantly decreasing the amount of supervision required of him.
    e. He always does the most important thing first.

Someone has said that the greatest waste today is unused brains. Why not use some of these brains on handling men? Henry Link says, "Engineers who are keen to use scientific methods in thinking about materials often abandon all semblance of science when thinking about people."

President Davis of Stevens Institute has said, "We all need to know more about handling men than any of us know today."

We have outlined what industry needs as to trained leaders. By close coöperation between educators and industry it should be possible for educational institutions to furnish more and more engineers trained in fundamentals who can more quickly and successfully develop into effective handlers of men. The engineer who can do this successfully will be a leader. He will have a passion for excellence and a desire to serve.

ACCURACIES OF DIFFERENT TYPES OF EXAMINATION QUESTIONS

By A. G. CONRAD,

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AND

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There is not a unanimity of opinion among engineering educators as to what type of examination questions are most accurate in determining the accomplishment of a student in an engineering course. A review of the literature on this subject shows that personal opinions in this matter have led to different practices in different institutions, and in different courses. To be more specific, we find that some educators prefer the new type or objective type of question, some prefer the subjective type, some the essay type and still others the project type.

Undoubtedly, there are certain courses where any one of these types of questions may be superior to other types, while in other courses this same type might be inferior. How then are we to know which are the best? The writers believe there has been considerable guess work on this issue. It would be well for engineering faculties to spend a little time on a scientific approach to this problem to determine precisely which types are, and which types are not, meritorious. Specific data on this subject are more helpful than discussions of individual preferences.

Before attempting to evaluate these different types of questions, it might be well to review the fundamental purposes of the examination itself. The value of any question naturally depends on the extent to which it fulfills these purposes. There are many of these purposes but the three most important are as follows:

1. To measure the accomplishment of the student.
2. To focus the attention of the faculty on their objectives and to serve as a means of checking the effectiveness of their teaching.
3. To reveal to the students any deficiencies in his preparation and to direct him toward more effective study.

How then do the various types of examination questions fulfill these purposes? The grades received by a student on his examinations should be indices of his accomplishments. The more accurate that these indexes can be made, the more useful will be the examination. The grades received on an examination should be a measure of the extent to which these three purposes are fulfilled.

What is the best type of examination question? Which type of question serves as the best index of the accomplishment of the student? In order to determine which questions in a particular course were superior in this respect a correlation has been made of the results obtained on various types of examination questions with the accomplishments of the students. This correlation, while subject to slight errors, shows conclusively that some types of questions are much better indices than others. Of the six different types investigated, the one that seems to be the best index is distinctively one of the objective types of questions. Conclusion in this matter is based on the results obtained from answers to questions received from seventy-nine students each of whom have taken ten different examinations. Each of these examinations contained six different types of questions. The averages received by the students in each type of question on these examinations were recorded. The grades received on each of these types were then correlated with the grades received in the course to determine their relative merit.

The examinations were given to a group of students enrolled in Industrial Administration who had scheduled an elective course in Electrical Engineering. This is mentioned here so that the reader will not confuse the questions here described with those that would normally be prepared for the regular Electrical Engineering students.

Types of Questions Investigated

The types of questions (not complete examination) used in each part are as follows:

Part A. Incomplete statements (15% of the examination)

Complete the skeleton statement in the following:

1. A power company finds on the basis of cost of electrical energy and the cost of copper that the most economical size of wire required to supply a given load at a given distance is 50,000 circular mils. If this same company is to supply an equivalent load at twice the distance from the source the most economical conductor size will be.....circular mils.

2. The terminal voltage of a shunt generator decreases with increase of load because of (1).....(2).....(3).....

Part B. (10% of the examination) True and False

If true, draw a line through false and vice versa.

1. If the voltage supplied to a series motor decreases when it is driving a constant torque load the current will not change.
True False

2. The armature resistance of a D.C. generator is equal to its rated voltage divided by its rated armature current.
True False

3. If the A.C. voltage supplied to a synchronous motor operating at unity power factor decreases the motor draw a leading current from this line. True False

Part C. (20% of the examination) Multiple Choice

Encircle the letter preceding the clauses that make the following statements true.

1. A motor used to drive a metal punch press should have a speed-torque characteristic such that the speed
(*a*) increases (*b*) decreases (*c*) remains the same
with increase of load torque.

2. Low lagging power factors in A.C. systems are

(*a*) detrimental because they increase the size of transmission and generating equipment for a given amount of power.
(*b*) advantageous because a larger current and voltage are obtainable at lower values of power.
(*c*) advantageous because the lagging current in the transmission lines gives better voltage regulation.

Part D. (15% of the examination) Circuits

It is desired to have the relay close its contacts when the beam of light is intercepted. Show the necessary connections. (Also additional apparatus, if necessary.)

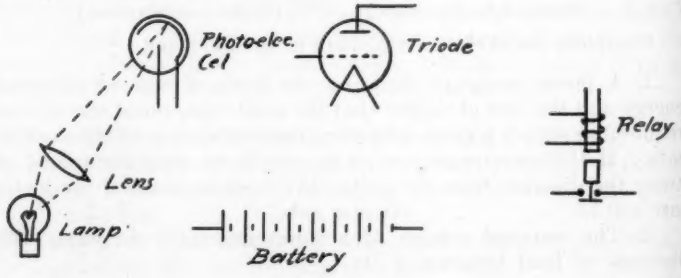

FIG. 1

Part E. (15% of the examination) Diagrams and Derivations

1. The speed torque curve of an induction motor is shown below for the conditions of normal operation. Plot on the same axes the speed-torque curve of this motor when operated on half normal voltage at half normal frequency.

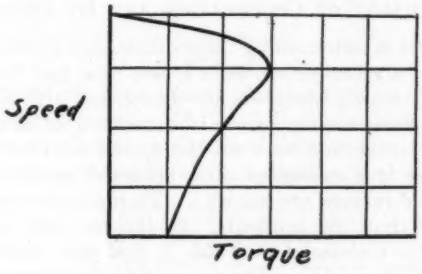

FIG. 2

2. If a pure inductance of L henries is supplied with a current $i = I$ max. sin wt, show that

(*a*) $\dfrac{E \text{ max.}}{I \text{ max.}} = 2\pi fL.$

(*b*) That the current lags the voltage by 90°.

Part F. (25% of the examination) Problems

1. A D.C. shunt motor rated 20 H.P., 220 V., 1000 R.P.M. takes 80 amperes from the line at rated load. The no-load current is 8 amperes. The resistance of the shunt field circuit corresponding to normal excitation is 73.5 ohms. The resistance of the armature circuit is 0.16 ohms. Neglect armature reaction.

(*a*) The armature current at rated load is.....amps.
(*b*) The no-load speed is.....r.p.m.
(*c*) The percent speed regulation is.....%.

Consider the flux to have been reduced 20%, the developed torque remaining the same.

(*d*) The new steady state value of armature current is..... amperes.
(*e*) The new steady state value of speed is.....r.p.m.

2. A three phase load rated 1000 Kw., 10,000 V., 60% P.F. lagging is served over a 10 mile transmission line. The resistance of the transmission line per mile of wire is 0.7 ohm. The reactance is 0.7 ohm per mile of wire.

(*a*) The line current is.....amps.
(*b*) The voltage at the sending end of the system is.....volts.
(*c*) The power factor at the sending end of the system is .....%.
(*d*) The percent regulation is.....%.
(*e*) The transmission line efficiency is.....%.

The Coefficient of Correlation and Its Determination

The method of determining the coefficient of correlation between two ratings of a group of students is not new, but the writers find not many engineering educators are acquainted with the procedures. We will therefore review briefly the method of determining the coefficient of correlation between the marks received on an examination and the true ratings of these students (assuming, of course, that these true ratings are known). To make the problem simple let us assume that four students, (*a*), (*b*), (*c*), and (*d*), receive the grades listed in Column I of Table 1, and that their true ratings are listed in Column III. The average of the examination grades is in this case 55%, of the true rating 82%. The deviation of each examination grade from the average examination grade is listed in Column II. These will be referred to as A. Similarly the deviation of the true ratings from the average rating is listed in Column IV. These will be referred to as B. In Column V and VI are the squares of A and B respectively and in Column VII is the product of A and B with due regard to the sign.

Table 1

Student	I Exam. Grade %	II Exam. Dev. from Average A	III True Rating %	IV True Rating Dev. from Average B	V A^2	VI B^2	VII $A \times B$ +	VII $A \times B$ −
a	40	−15	67	−15	225	225	225	
b	50	− 5	85	+ 3	25	9		−15
c	60	+ 5	80	− 2	25	4		−10
d	70	+15	90	+ 8	225	64	120	
Average	55		82					
				Sum	500	302	345	−25

$\Sigma(A \times B) = 345 - 25 = 320$

In this case—

$$\Sigma(A \times B) = 320$$
$$\Sigma A^2 \times \Sigma B^2 = 500 \times 302$$

The coefficient of correlation (r) is now determined from the following relation

$$r = \frac{\Sigma(\text{dev. from average in the exam. grade}) \times (\text{dev. from average in the course grade})}{\sqrt{\Sigma(\text{dev. from average in the exam. grade})^2 \times \Sigma(\text{dev. from average grade})^2}}$$

$$= \frac{\Sigma(A \times B)}{\sqrt{\Sigma A^2 \times \Sigma B^2}} = \frac{320}{\sqrt{500 \times 302}} = .83.$$

A correlation this high is considered good. A graph, Fig. 1, showing these grades also indicates that this examination is quite accurate in determining the standing of the student. If these points in Fig. 3 were so located as to fall on a straight line having a positive

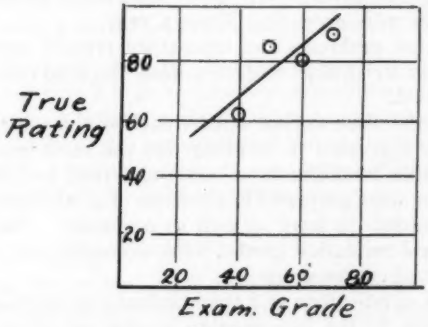

FIG. 3

slope the coefficient of correlation would be 1. If they fell on a straight line having a negative slope the coefficient would be -1, which would indicate that the examination had given a negative correlation, *i.e.*, the students receiving high grades are the poor students and vice versa.

The sample calculation made is subject to error. Accurate determinations can be made only from data involving a large number of students.

A correlation of 1 would be perfect; a correlation of zero indicates that the examination is of no value in determining the standing of the students. Examinations with correlations below 0.5 are considered of little value.

METHOD OF OBTAINING COURSE AVERAGES

Final grades were not based on the results of the objective type examinations alone, but were an average of the grades made on the objective examinations and grades obtained from more standard

sources, or from subjective material. Grades determined on a subjective basis were the results of examinations in laboratory work, tasks performed as a part of laboratory examination, problems done in computation periods, laboratory reports, project work, ten minute papers and oral recitation work.

The written part of the laboratory examinations were of the essay type, and were subjective in nature. They required considerable written explanation on the part of the student.

Laboratory tasks were assigned to the students on the same day that they took their written laboratory examination. In performing their tasks the student made use of the laboratory equipment, making the electrical connections and necessary measurements to obtain the answer to the task question. Instructors graded the student with reference to his choice of method, accuracy, correctness of wiring and protection. Both laboratory written examinations and tasks were given four times a year.

Computation problems and laboratory reports were submitted weekly. Their weightings in determining the final course grade are listed in Table 2.

Four projects were worked out by each student during the year. These usually consisted in working out the most economical and most serviceable installation of some electrical installation. The project reports were prepared in the form of a standard engineering report and graded on form as well as accuracy. The ten minute papers and oral recitation grades were averaged and included as a part of the total course grade.

The types of questions and the maximum percentages that they may contribute to the examination grades are given in Table 3. During the year there were eight one-hour and one two-hour final examinations of the type described.

These examinations entered into determining the final course grade by the ratios indicated in Table 2.

TABLE 2

	Possible Total Points
Laboratory Examinations	400
Laboratory Tasks	400
Computation Problems	100
Laboratory Reports	100
Projects	400
Ten Minute Papers	100
Oral Class Grades	100
Objective examination, including final	1200
Maximum possible total =	2800
Maximum possible grade = $\frac{2800}{28}$ =	100%

Each objective examination, including the final, was made up of the different types of questions illustrated. The percentage assigned to each type of question on each examination and the percentage of the final course grade that depends on these particular types are listed in Table 3. The percentage of the final grade

TABLE 3

	Percentage of each Examination	Percentage of final grade determined by aceh part of Examination
Type *A*	15	6.4
" *B*	10	4.3
" *C*	20	8.6
" *D*	15	6.4
" *E*	15	6.4
" *F*	25	10.7

determined by each part of the examination is determined as follows: From Table 2 it is evident the 1200/2800 or 42.9 per cent of the final grade is determined from all the examinations including the final. Therefore, the percentage of the final grade determined, say by the Part *A* questions which constitute 15% of each examination, would be $0.15 \times 42.9\%$ equals 6.4%.

Conclusions

In order to determine which part of the objective examination gave the best indication of the student's accomplishment, a statistical study of the grades received by seventy-nine students was made. The individual parts of the examination were studied with respect to the final course grades. Percentages received on each part of the examinations were averaged and then by the method previously described the coefficient of correlation between the grades on each part and the final course averages were determined. The results of these determinations are shown in Table 4.

TABLE 4

Type of Question	Coefficient of Correlation
Part *A*	.72
" *B*	.71
" *C*	.88
" *D*	.65
" *E*	.63
" *F*	.82
All Examinations	.93

When the results of these examinations, which have required only twelve hours on the part of the students, are correlated with the final course averages the coefficient of correlation was found to be .93. This is a very high correlation.

There is very little difference between the validity of Part *A* and that of Part *B*. Likewise there is little difference between the validity of Part *D* and that of Part *E*. Parts *D* and *E* which are types of questions commonly used are somewhat subjective in nature. Parts *A*, *B*, and *C* are decidedly of the objective type. Part *F* has the second highest correlation, but it is to be expected since a large portion (25%) of the examination was devoted to this part. Since correlations above .70 are considered good, it is evident that these objective types are meritorious. The type described as Part *C* is far superior to the other types in fulfilling the three purposes of an examination. Because of its high coefficient of correlation it reveals to the student his deficiencies and his accomplishments. It serves as an accurate guide for the faculty in checking the accomplishments of the class and the effectiveness of their teaching. It accomplishes its purpose because its correlation is high. If it had a low coefficient of correlation, it could not fulfill its purposes and it would in many cases be misleading to the faculty and the student. In spite of the high correlations often obtained with objective types of questions few engineering educators use them either in course or comprehensive examinations.

There are many different procedures and methods that are in use today in what are called the comprehensive examinations. It would be interesting to know just how the results of these comprehensive examinations check with the true ratings of the students. There are many procedures that should be statistically analyzed to determine their value. It would be time well spent for engineering faculties to investigate the results obtained on closed book examinations versus the open book examination, where the element of luck in finding the proper reference material may play an important part in determining the final examination grade. It would be well to investigate the accuracy of the oral examination. Such investigations will help to eliminate some of the procedures that are unfair to the student and misleading to the faculty.

An examination administered at the end of the four year period standing alone does not fulfill the purposes which are listed as being of paramount importance. On the other hand if periodic examinations are given, say once a month, in the courses and the questions are of the type that will reveal to the student his accomplishments and his deficiencies, then they can be a most effective part of an educational program. But if such questions do not have

reasonably high coefficients of correlation, they can be misleading to the faculty and unfair to the student.

It is difficult to obtain correlations when classes are small, and it is impossible to obtain correlations of any value on an examination when there is no basis for determining the true rating of the student except from these examinations. Even though these factors make true correlations difficult we can frequently minimize these errors by dealing with one part of the examination and comparing it with other parts to determine their relative values as has been described in this paper. It is hoped that the methods and results here described will encourage other statistical investigations of other types of questions, or types of examinations.

There is still much to be done in the development of suitable comprehensive examination questions. There is a need for better types if our objectives are to be fulfilled. In the writers' opinion these better types can be found only through a STATISTICAL analysis of the results obtained through their use. SPECIFIC INFORMATION will be helpful, more so than MERE GENERALITIES.

TEACHING LUBRICATION *

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The subject of teaching lubrication may very properly be taken up under three heads: first, why teach lubrication at all? second, granting that a need for teaching it can be shown, how should it be taught? and, third, at what time in the student's academic life should he receive this instruction? As a background to an examination of these questions, let us first take a brief glance at the history of lubrication. Let us see, if we can, what the origin, development, and present status of the science is.

While the practice of lubrication is extremely ancient, and its origin is lost in the mists of antiquity, it seems likely that the first experiment in lubrication came shortly after the introduction of the wheel. Certainly the use of fats to reduce the wear on and friction of chariot wheels was known to the Egyptians. The method of application, at that time, consisted in removing the wheel, smearing grease on the axle, and replacing the wheel, or else, if an oil was used, dripping it through a hole bored in the hub, and leading to the surface of the axle. These types of lubricants and methods of application persisted without much change from before the dawn of history to the latter half of the nineteenth century, and this period may be referred to as the grease-bucket and oil-can age. It still persists in many quarters.

Real advances in the science may be dated from the work of Beauchamp Tower in 1883, and Osborne Reynolds' mathematical explanation of it in 1886, although important groundwork had been done previously by Newton and Petroff.

Since the turn of the century interest in the subject has increased rapidly, with important contributions being made, first by Kingsbury and later by Hersey and Howarth in this country and Boswall, Sommerfeld, Trillat and others abroad.

Today the experimenters' and writers' name is legion and one can scarcely pick up an engineering periodical, or even a daily paper, for that matter, without seeing some paper, article, or just plain story dealing with the subject of lubrication. This brings

* Presented at the 47th Annual Meeting, S. P. E. E. (Mechanical Engineering), Pennsylvania State College, June 19–23, 1939.

us to a consideration of why the subject is attracting so much attention, and constrains us to appraise its importance.

The purpose of any machine is to transform energy into useful work, and to accomplish this transformation with the smallest possible loss of energy. It must also perform its function with as little wear of itself as possible. Were our machines frictionless the losses would be exceedingly small and the wear negligible. Under existing conditions the losses due to friction run anywhere from 15 to 90 per cent of the power supplied. The reduction of friction, therefore, offers possibilities of large savings. Great efforts are put forth, and elaborate designs of boilers, engines, turbines and auxiliary equipment are prepared in order to increase the efficiency of the production of energy, and so save our natural resources of fuel. That is laudable. The same or even a much greater saving might be secured by a reduction in the friction losses occurring in the machines using that hard-won energy. Could we but cut our range of friction from the 15 to 90 per cent quoted above to, say, 5 to 45 per cent, half of the fuel now being used could be saved, or, perhaps, I should say, twice the useful work could be done. Moreover, machines wear out because of intimate contact between the rubbing surfaces. This, in turn causes shutdowns to permit adjustment and repair, and the cost of this service must be added to the cost of the energy lost in friction.

Lubrication offers the best means found so far for reducing the twin evils of friction and wear. The gains made possible by an enlightened application of the knowledge we already possess are so large that the wonder is not that the subject is attracting such widespread attention now, but that this attention has been delayed so long. Furthermore, our knowledge of the subject is by no means complete. There are many fields in which our knowledge is so inexact as well as incomplete, that we have almost as many theories as we have authorities, and all of the latter are vocal. Such conditions excite the curiosity and stimulate the activity of the research worker. The true facts must be developed, and theories that will explain them must be stated.

I think we may safely answer the question "why teach lubrication?" by pointing to the great benefits to be derived from the use of our present knowledge, and the crying need for more knowledge of those portions of the field whose exploration has just begun.

The science of lubrication may be divided broadly into two major divisions, thick film lubrication and boundary lubrication, each of which has many subdivisions. Each has its own phenomena and its own laws. Save for the fact that each accomplishes more or less the main purposes of lubrication they have little in common.

While important basic work bearing upon factors entering into the theory of thick film lubrication was done by Newton, Petroff, Lamb and others, our present day conception of the mechanism of thick film lubrication dates from Osborne Reynolds' explanation of some phenomena noted by Beauchamp Tower. Reynolds provided the mathematical work that has been the basis of all the theoretical work done since his time. That was in 1886. Nothing really new has been developed since. The brilliant work of Michell and others has merely brought solutions of problems indicated by Reynolds, but not solved by him, such as the problem of correction for end leakage.

The science of thick film lubrication is in a satisfactory condition, from the standpoint of the teacher. It rests on a well developed mathematical basis, the validity of which has been fully demonstrated by experimental work. The behavior of any bearing in which thick film conditions obtain can be predicted with a very respectable degree of accuracy. Such errors as do occur are due more to a lack of knowledge of details than to any inadequacy of the theory. Such a subject lends itself readily to transmission to the student, provided the mathematical work involved is not too complex.

The second major field, that of boundary lubrication, presents an entirely different picture. Here no one knows certainly what goes on, and no satisfactory and proved mathematical theory has been developed. It is a field that has been as changeable as the fashions that come out of Paris, and to make matters worse, the writer of advertising copy has taken up each pronouncement of the real and also of the pseudo-research worker, and twisted it until even the original author has difficulity in recognizing it. Even the definition of the terms is debatable. Let me call your attention, for example, to the term "oiliness," and ask you to think of the various definitions you have heard for this word. My own list runs from "the property, other than viscosity, that causes a decrease in the coefficient of friction" to "the property which causes an increase in the translucence of a photometer screen."

The first reason for all this confusion seems to lie in the fact that boundary lubrication is lubrication by means of exceedingly thin films. By that I mean films of molecular dimensions. These films are very hard to produce with uniform thickness. It is only within the last few months that a method which seems adequate for the deposition of petroleum lubricants has been described by Walter Claypoole of The Texas Company.

The second reason seems to be that the behavior is affected profoundly not alone by the character of the lubricant but also by the material of which each rubbing surface is made, and the finish of

each surface. It is no wonder that results have been discordant and explanations plentiful. Research now in progress gives great promise of bringing order out of chaos in this field. Let us survey, briefly, the lines these researches are following.

First we may list the investigations into the relationship of viscosity to pressure. This varies considerably with different lubricants, and this fact has not been given due weight in the past. Certain of the phenomena of heavily loaded bearings formerly attributed to boundary effects can now be shown to be due to the variation of viscosity with pressure.

Next comes the use of X-ray and electron defraction patterns to determine the actual structure of the film itself. This may lead to a method of evaluating both the effects of the lubricant and of the surface.

At present we are unskilled in the use of these new tools of investigation. We have high hopes, but not enough accomplishments to warrant any sweeping conclusions being drawn.

Finally comes the application of criteria to evaluate the findings of the researches into viscosity and film structure. In doing this we must recognize at least three criteria. First and most generally used is the criterion of friction; second, that of wear; and third that of seizure. The excellence of a lubricant when judged by one of these, does not necessarily guarantee its excellence when judged by either of the others. Much more correlating work needs to be done before we can say what a certain film structure or pressure-viscosity relationship means in terms of friction, wear, or seizure.

The foregoing constitutes a brief and very sketchy picture of the subject the teaching of which we are to consider. It would appear that the question "Shall we give instruction in lubrication?" should be answered in the affirmative, because of the large part lubrication plays in not only the design of our machines, but also in their life and economy of operation. Let us now turn to the consideration of subject matter, timing and methods.

It has been pointed out that the mathematical basis for the science of thick film lubrication was set forth by Osborne Reynolds in 1886, and that since that time it has been unchanged, save for refinements. Why did this exceedingly valuable and powerful method remain unknown, save to scholars, for so long a period? I think the answer is to be found in the formidable mathematics involved in the actual working out of very simple concepts. The average designer has not the command of mathematics necessary to cope readily with the equations in the form in which Reynolds left them. This statement applies with equal force to the students found in our undergraduate curricula and with somewhat less force to their instructors. Reynolds needed a translator to place his find-

ings in a form that the ordinary practicing engineer, or student, could use without undue effort.

In 1923 this translator appeared in the person of H. A. S. Howarth, then Chief Engineer of the Kingsbury Machine Works. He took Reynolds' work, as modified by Harrison, and translated it into a series of charts that anyone who could add, subtract, multiply and divide could use. These charts did much more than this. They gave a clear visual picture of the whole mechanism of thick film lubrication, and the inter-relation of the various quantities involved. What had been clear formerly to the skilled mathematician, now became almost obvious to the average engineer. To be sure Howarth's charts published in 1923, '24 and '25 dealt with bearings of infinite length only, and were not applicable in a quantitative way, to real bearings. He, however, pointed the way to making the classical theory readily available, and the modification of his charts to take care of end-leakage effects, was quickly accomplished. Others extended the path he indicated, and today there are available charts to cover almost any set of conditions met with in bearing design.

Kingsbury has a most useful set dealing with Optimum Conditions in Journal Bearings. Karelitz, Tichvinsky and Barber and Davenport have all published charts which the engineer can use with confidence and celerity. The design of bearings which operate under thick film conditions involves today no more uncertainties or arduous calculations than does the design of any other part of the machine.

The study of thick film lubrication should form the backbone of any course in lubrication, and it can be expedited by the use of one or more of the charts referred to. If time is available the origin and development of the charts should be traced. If not, their application can be shown, and a great deal of practical benefit can be derived.

If models are available their use will aid greatly in fixing the underlying principles of thick film lubrication in the mind of the student. I have here two models which I use in giving instruction to students in mechanical, industrial and electrial engineering. Both are air lubricated. One, the Kingsbury, has pivotted shoes which are free to tilt in any direction, thus allowing the required convergent channel to be formed. It is reversible. The other, the Gibbs, has fixed shoes, which are scraped to a taper on the leading two thirds. The convergent channel here is fixed in direction, and the bearing is not reversible. Any student who sees these models in action will remember that a channel convergent in the direction of motion is necessary to the formation of a load-carrying film.

No such happy and definite solution exists for the problem of

teaching boundary lubrication. Here the knowledge consists mostly of fragments, many of which are discordant, and even the authorities do not agree on what is true. We are not even certain of the conditions under which thick film lubrication ceases and boundary lubrication begins. Furthermore, because of the intensive research being carried on in this and allied fields, the state of our knowledge is apt to change over night. There is no proved mathematical theory, and there are no charts to ease our labors. Under these conditions the problem becomes one of selecting the best available material, in such quantity as may be suitable to the time available, and presenting it as such. Reference should be made to the original publications of the investigators, and great care should be taken to avoid extreme claims which are unsupported by substantial evidence. Perhaps the greatest service that can be rendered the student by this study is to make him aware of the possibilities of boundary lubrication, and the limitations of our knowledge. His chances of being a victim of unsound advertising of nostrums are thus reduced to a minimum, and his ability to evaluate the claims of the purveyors of proprietary lubricants is enhanced.

The refining of lubricants is a field in itself. Its broad principles may be sketched briefly, so that the engineer may have some acquaintance with the language used. The details belong to the realm of chemistry or chemical engineering. Their inclusion in the work given to other engineers would involve the expenditure of much more time than is ordinarily available.

The question of whether or not to include a study of devices to apply lubricants is debatable, and the answer depends on the amount of time available. Some time undoubtedly can be devoted to this work. I feel, however, that a knowledge of lubricating devices already existent can be gained by anyone who will devote a few hours to perusing trade catalogs. The devising of new means of applying lubricants may be safely left to the ingenuity of the individual needing it, providing he is fully aware of the results he desires to accomplish, and the natural laws to which he should conform. All of this can be done as well or better after leaving college than in the classroom. In the classroom we should, as far as possible, teach that which is fundamental and unlikely to be acquired elsewhere. So much for what should be taught. The next question is when.

Three possibilities are open: First, it may be taught in the undergraduate school, either as a separate and distinct subject, or else as an incidental to the work in machine design ordinarily given in the junior and senior years. This scheme has the advantage of bringing into contact with it all students likely to need such

knowledge. Its great disadvantages are that but little time is available and that juniors are, after all, not very mature.

Second, it may be taught wholly in the graduate school. Here much more time is available, the students are of superior quality and are sufficiently mature to exercise discretion in accepting controversial and speculative statements. There are, however, not many of them, and if this time is chosen the greater part of the student body will not come into contact with the work.

Third, it may be divided. A brief summary of principles adapted to the capabilities of the students and the time available may be inserted into the orthodox course in machine design. A more complete course devoted entirely to the subject may also be given in the graduate school.

The third alternative is decidedly the best. Let us examine more closely the make-up of each of its divisions.

If lubrication is to be taught as a part of the general course in machine design it must be so condensed and abbreviated that not more than four to six assignments will be required for its presentation. What is presented must also be as devoid as possible of indefinite and apparently contradictory statements, which require considerable judgment to interpret and apply correctly. At the same time the work should drive home as well as possible the reason a bearing works. The purely empirical should be minimized.

These considerations indicate that a presentation of the underlying principles of thick film lubrication, coupled with some practice in using the charts, is desirable. The mathematical derivation need not, in fact, cannot be gone into because of the short time available.

With this knowledge clearly in mind the student is likely to design bearings, if he has to do so, in such a way as to make the conditions most favorable for the formation and maintenance of an oil film. He is unlikely to cut oil grooves from regions of high film pressure to those of low, and to think that in doing so he is taking the oil in to the place where it is needed. He will know that such grooves act as drains, and that they do more harm than good. He will also know qualitatively the relationship of oil viscosity to bearing capacity, and hence appreciate the importance of taking away the heat of friction. The effect of clearance will be understood in a general way, and he will have an idea of the thickness of this film which prevents wear of the rubbing surfaces. In short he will have a pretty good idea of the direction in which his efforts should lead, and that is more than can be said for many older engineers. I feel that it is unwise at this time to give the undergraduate much on boundary lubrication. Unless the discussion of that

subject should be quite extensive false impressions can easily be given.

In the work given to graduate students we have much greater latitude. To begin with, the students themselves are a selected group with better mental equipment than the average undergraduate. They are provided with the necessary mathematical, physical and chemical tools, and are more mature. They are much better able to weigh evidence and appraise scientific and pseudo-scientific investigations. They are ready to undertake a really thorough study of the subject of lubrication.

In the graduate course, as in the undergraduate, the study of the hydrodynamical theory should form the backbone of the work. In the advanced work, however, the mathematical basis for the charts can be gone into thoroughly. In fact it is quite desirable for the students to plot a few of the curves, just to see how the charts are made. If an integraph is available about 90 per cent of the labor of integrating the differential curves can be eliminated, and more accurate results can be secured than is likely if the integration is carried on by means of a planimeter.

Unfortunately there is, so far as I am aware, no satisfactory textbook on the subject of lubrication. There are reference books, treatises, handbooks, dissertations, and almost any other classification of writing upon the subject, but no text written for students who know nothing about the subject, but who have the desire and ability to learn. We have excellent texts on all the other divisions of machine design subjects, from drawing and lettering to torsional vibrations and balancing. These occur in great abundance and variety, and each serves well its own group of students. No one has yet written a textbook on lubrication, in which a full series of lessons can be assigned; a text that starts at the beginning, covers the principal items, and does so in language that is at once simple, authoritative and interesting, and, with it all, short enough to be covered in from forty to ninety assignments of reasonable length.

Lacking a satisfactory text we must fall back on the old reliable lecture system, and reinforce that by assigned readings in the various scientific papers presented from time to time before learned societies. This method entails a great deal of work on the part of the instructor, who must read widely before he can make a proper selection of assigned readings. It also lays a considerable task on the student, for the papers are not written for him, but rather for men who are thoroughly familiar with the subject. The student will often find himself in the condition of the mathematician who complained of the brevity of LaPlace's

work. He said "When LaPlace says 'hence it is obvious' I know I am in for a week's hard work."

The lecture method of teaching is not an unmitigated evil. It possesses the great advantage of flexibility, and this is extremely valuable when dealing with a subject which is developing rapidly. The opinions and facts offered in a textbook are at least three to five years old. Those in a lecture may be as recent as a month. The subject taught by lecture is, therefore, much more likely to be abreast of the times than it would be with textbook instruction.

So far I have not mentioned the part, if any, that research should play in teaching lubrication. I feel strongly that research is a most valuable and essential adjunct to the recitation and lecture work of the graduate student. I do not believe the undergraduate has enough time to devote to research to make it of much value to him. The great value in research lies not in the additions made to the world's store of knowledge, but in the close, intensive study of the known laws in order to explain and interpret the unexpected phenomena that always appear. This forces the research worker to obtain a grasp and understanding of the allied and contiguous fields, and gives him a clear, logical and sound picture of their relation to his own. It requires him to lay hold of the substance as well as of the form of principles with which he is dealing. He must see clearly, where before he had, in the words of St. Paul, "seen through a glass darkly." Research also performs the very valuable service of giving impetus to the student's voluntary study and sharpening his interest in the subject.

Now let us see where all this discussion has brought us. I think we can say that the subject of lubrication merits the serious attention of mechanical engineering departments, because of its importance to the operation of all kinds of machinery. Its consideration is logically a part of the domain of machine design. That division should assume the responsibility for such instruction as is offered, and should blend it into the larger subject of the design of machines.

Undergraduate work can be made a portion of the basic course in machine design offered to juniors and seniors. The basic concepts and the use of charts in bearing design can be given at this time, but the difficult mathematical derivations of these charts and the controversial subject of boundary lubrication should be omitted.

Research is not desirable or feasible for the undergraduate.

A complete course of from three to six semester credits should be offered in the graduate school. This can, and should, cover the classical hydrodynamical theory, the derivation and use of the charts based on it, and as comprehensive a presentation of the

phenomena of boundary lubrication as the time available will permit. Great care should be taken, however, to keep before the students the application of all of this knowledge to the design and operation of machines. The work must never be permitted to become merely mathematics and physics. It must always be engineering, and to be engineering it must indicate the practical application to actual machines.

Lubrication offers an almost ideal field for the research worker because there are several large problems which may be split into many smaller ones, all of which are interesting. A major problem can be attacked in detail by many students, and thus comparatively rapid advances can be made.

In most cases the apparatus is neither very complicated nor expensive, and can largely be made by the worker. It thus confers the dual blessings of developing the mind and training the hand.

Lubrication is a fine subject for study. May it be accorded the place and prominence to which it is entitled.

Discussion

L. M. Tichvinsky, Westinghouse E. & M. Co.: In 1886 the hydrodynamical theory of lubrication was first advanced by Petroff and Osborne Reynolds. Petroff was an artillery general possessing excellent mathematical ability, while Osborne Reynolds was a renowned scientist of world reputation.

It is evident that at that time, over fifty years ago, the existing machinery hardly warranted, we believe, the use of a complicated theory which, as a matter of fact, was not yet simplified in order to be used by design engineers.

One of the first experiments to verify the hydrodynamical theory was made in 1905 by Mr. Kingsbury * when a 15″ diameter bearing lightly loaded rotated at 300 r.p.m. At that time such bearing performance was new and experimental support of the results obtained using the hydrodynamical theory was necessary.

At the present time the engineer is confronted with the problem of bearings which are heavily loaded, rotate very fast, and consequently absorb considerable energy. Such successful and safe performance is effected only on account of the thorough knowledge of the mechanism of lubrication. Modern engineering places continually new problems in the hands of designers, who, without adequate theoretical preparation, could not successfully build one of the most important elements of any rotating machine: the bear-

* A. Kingsbury, "Tests of Large Shaft Bearings," the *Electric Journal*, Vol. III, p. 464, 1906.

ing, by itself a remarkable machine in which a load of millions of pounds is carried safely on a thin film of fluid. The theory explains how this is possible and engineers use it for sound and rational design.

The theory of lubrication is now an important item in the course of any engineering school since it helps to understand the fundamentals of all types of friction, as well as the complicated mechanism of wear.

It seems to the writer that the paper by Professor Bradford gives all reasons and indications of the importance of this branch of engineering which was not vital at all a generation ago.

G. B. Karelitz, Columbia University: There is very little that can be added to Professor Bradford's remarks on "Teaching Lubrication." He covers the ground very well and I thoroughly subscribe to his analysis of the possibilities in organizing the teaching of the subject.

In fact, the course on Lubrication which is being given at Columbia University follows exactly the lines laid down by the author. We have a very short review of the hydrodynamics of perfect lubrication in the course on the mechanics of machinery. The information there given is just sufficient for the student to understand what is going on in a simple power bearing.

The chapter on Bearings in Stodola's "Steam Turbines," with a few additional papers, is used as a reference for this part of the course.

An elective course in lubrication for senior students is later given to cover the whole field, not only of perfect lubrication but also boundary lubrication, bearing metals, roller bearings, etc.

A large number of references in current literature and a number of problems are used as assignments in that course. We, however, do not do any research work in the subject unless some of the students choose a thesis for their degree in this field. This happens rather rarely, due to the fact that setting up a test in this field takes much effort, and is difficult.

I realize that other institutions where the mechanical laboratories are better provided for experimental work than is the case at Columbia, might very well conduct researches in the field with benefit to the students and to the art.

Arthur E. Norton, Harvard University: The need for a better understanding by engineers of the fundamentals of lubrication came forcibly to my own attention about 12 years ago when I was asked to serve as adviser to a group of industries on problems of lubrication with special reference to the maintenance of their bear-

ings. My contacts were with the plant engineers in charge of millions of dollars worth of machines and responsible not only for their proper functioning, with minimum annual expense, but also for the decision as to types of machines and types of lubricants to be purchased.

I was impressed with the uncertainty of these engineers concerning the fundamental principles of lubrication, but also by their intense desire to find out those principles as an offset to the sales talk of overzealous salesmen. Hitherto I had regarded the subject as a highly specialized field of design which could not be taught successfully in school. But in trying to solve the everyday problems of these plant engineers I was always forced to go back to the fundamentals as a true guide.

As a result of this experience I introduced into the *undergraduate* course in machine design practically the same topics as recommended by Professor Bradford for undergraduates. However, one important phase he did not mention. I refer to the need for much more attention to the mechanics of shaft reactions and bearing forces. I believe that most lubrication troubles in machines are due to mistakes by the designer or purchaser in figuring out the magnitude and direction of the load on the bearing. In ordinary journal bearings the *direction* determines the proper location of oil hole; in ball bearings the magnitude is necessary to be known if overload is to be avoided.

It will be urged that this is merely a matter of statics which should have been learned in the sophomore year, but every teacher knows that covering the subject in a previous course does not mean knowing it in the senior year. As a matter of fact, bearing problems involve non-coplanar forces with a possibility of five or six unknown quantities, and very many college courses omit this type of problem in the earlier years. However, the extra time needed for discussion of problems of this sort in the senior year should not be charged wholly to lubrication, for the same computations are needed for determination of reactions to shafts as a means of computing stresses. Except for this kind of practice, which may occur in the junior year, I believe that undergraduate instruction in lubrication should be delayed to the senior year and should be a part of a course in machine design. It is my experience that senior students invariably regard lubrication as a pleasant diversion after the long and sometimes tedious study of stress and strain. I find that the little model of a Kingsbury thrust bearing running with air as a lubricant serves as a very exciting introduction to the whole subject. Another aid is the moving picture film, several of which can be obtained from the oil companies.

It is also possible in the senior year to present the well-known *ZN/P* diagram as a characteristic curve for journal bearings even though the mathematical theory is not studied in detail. By means of this diagram and a little explanation, the phenomenon of "oiliness" can be detected and the difference between the friction of mineral oils and fatty oils readily pointed out, even though the physical reasons for this difference may be obscure.

As to graduate instruction, I feel sure that a course on the theory of lubrication is justified in a school where some member of the staff is willing to take the time to delve into the subject and organize the material. I have been giving such a course for about ten years and find that one semester is none too much for a study of the fundamentals. A full year course would be necessary if laboratory work were included.

Lack of a suitable textbook, as Professor Bradford says, is a serious handicap. The two books which I have found most helpful are Hersey's "Theory of Lubrication" and Boswall's "Theory of Film Lubrication." The former gives a summary of the physics of lubrication and the history of its development. The latter provides a mathematical study of the action of different types of bearings. Even with these aids, I have found it necessary to work up my own mimeographed notes with charts based on technical papers by Boswall, Kingsbury, Howarth, Michell and others.

In any such course the fundamental aspects of ball, roller and needle bearings should be included together with a comparison of these bearings with ordinary journal bearings in order that engineers may be better prepared to make choices between these different types.

Any graduate course should aim not only to prepare engineers for advancing the science and art of lubrication but also to give these men a unified knowledge of materials. If properly taught, the subject of lubrication can be allied with the study of elasticity and plasticity, especially with the latter since the rate of shear is an important feature of both liquids and plastic materials.

James I. Clower, Virginia Poly. Inst.: This paper gives us many good and sound reasons why lubrication should be included in our technical curricula. It is my hope that engineering deans will heed his plea and make it possible to devote more time to this important subject than is now generally possible.

I believe that virtually all of us here will agree with Professor Bradford's conclusion that lubrication is sufficiently important to warrant its being taught. For the benefit of the doubting Thomases, however, I should like to point out that everything moves,

that nothing is stationary, and that the vast majority of things move on lubricating films. Setting aside graphite, glycerine, water, and perhaps a few other substances, the statement that the world moves on oil is not the least exaggerated. I am therefore in full accord with Professor Bradford that lubrication should be taught. I find myself, however, differing some with him as to the content of a lubrication course. I can perhaps express my views on this phase of the subject best by discussing briefly the two lubrication courses I have been teaching at V. P. I. for seven years.

Industrial Lubrication 412 is a technical optional course open to all senior students taking mechanical, electrical, chemical, and industrial engineering. It is mainly a lecture course. No textbook is used. It is a one quarter, three-credit course. The subjects covered in this course and the approximate percentages of the total time devoted to each subject are as follows: (*a*) Crude oils 5 per cent; (*b*) refining processes, 7 per cent; (*c*) physical and chemical properties of lubricating oils, 14 per cent; (*d*) methods and significance of tests, 13 per cent; (*e*) greases, 6 per cent; (*f*) laws of boundary and thick-film lubrication, 12 per cent; (*g*) lubricating appliances and systems, 10 per cent; (*h*) purifiers and purification, 8 per cent and (*i*) selection, application, and recommendations of lubricants for steam engines, steam turbines, air compressors, refrigerating compressors, and internal-combustion engines, 25 per cent.

Each student in this course is required to write five comprehensive papers on some phase of lubrication. A suggested list of subjects and references is given each student at the beginning of the course. This list of subjects is very general and the students are encouraged to make their own selection.

Lubrication Theory and Practice 522 is a graduate course for which Industrial Lubrication 412 is a prerequisite. Lubrication Theory and Practice is a three-credit course, consisting of two lectures and one laboratory period each week. In the lecture part of this course, a critical study is made of viscosity and its relation to friction; boundary and thick-film lubrication; theories of oiliness and seizure of bearings; and the rational design of bearings. The laboratory tests include: (*a*) the making of greases by commercial receipts; (*b*) neutralization number; (*c*) steam emulsion number; (*d*) Almen film breakdown; (*e*) dilution, water and sediment; and (*f*) viscosity by means of modified Ostwald viscosimeter. In this course, also, the students are required to prepare and present comprehensive papers on various lubricating subjects. These papers require on the part of the student considerable library work. Although no textbook is used in this course, "Theory of Lubrica-

tion'' by Hersey and ''Lubricants and Lubrication'' by Archbutt and Deeley are frequently referred to. Furthermore, current lubrication articles from such publications as *Mechanical Engineering, S. A. E. Journal, Journal of Industrial Engineering Chemistry, National Bureau of Standards Journal of Research,* etc., are reviewed and discussed. The students are required to purchase the current edition of the ''A. S. T. M. Standards on Petroleum Products and Lubricants'' and are urged to purchase ''The Significance of Tests of Petroleum Products.''

Both of these courses are optional, but the number of students expressing a desire to take them is greater than can be accepted. Industrial Lubrication is given during the fall quarter and two sections of 25 students each are taught. Lubrication Theory and Practice is offered during the winter quarter and is limited to 15 students because of limited laboratory space and equipment.

Industrial Lubrication is essentially a practical course. Since more engineering graduates find employment in plant operation than in design, and since there is a greater lack of knowledge on the part of engineers about the lubricants themselves and their practical use, I feel that the emphasis should be placed on the lubricants themselves and their practical use rather than on the theoretical design of bearings from the standpoint of lubrication.

Very few practicing engineers really know much about lubricating oils and greases. The majority of them depend on the smooth, velvety touch of the service station attendant to tell them when they should change the oil in the crankcase of their personal automobile. Most of them know so little that they cannot prepare really intelligent oil specifications; but they often do so and frequently include absurd requirements that mean nothing except a higher price. They are too dependent on the advice and information given them by oil salesmen and lubricating engineers who are, naturally, often over-zealous and prejudiced in favor of their own products. There is a decided tendency for representatives of oil companies to talk in general and fantastic terms about their products. The engineer usually stands aghast and listens to such glib prattle as ''heat- and wear-resisting,'' ''double refined,'' ''heat-proof,'' ''wax-free,'' ''non-gumming,'' ''heat insulated,'' ''acid free,'' and *ad infinitum* without knowing what it is all about or what to make of it all.

Furthermore, only a very few engineers have any conception of the fundamental factors for choosing lubricants for different machines that operate under various conditions of service. They know virtually nothing about the characteristics of different oils. This is evident by the fact that many equipment builders *give free*

with each new machine a sample of the correct oil and state that this oil was especially made for this particular machine and that no other should be used. The chances are ninety-nine to one that this *special oil* is nothing more or less than some oil company's regular brand that has been given a free and fancy brand name and the price tripled or quadrupled.

In our course "Lubrication Theory and Practice," it is our aim to acquaint the student with all past and present important literature on the subject; to have him understand what the current lubrication problems are in the different fields; what type of research is being carried on by the different laboratories and why; and what improvements and along what lines they are most likely to be made in the near future.

I can perhaps sum up my reaction to the question what should be taught by saying that lubricants themselves should be given the major portion of the time in any course.

Author's Closure: Professor Clower has made the point that the emphasis in a course on lubrication should be placed on the lubricant rather than on the design of the bearing, and gives as his reason the large number of nostrums finding their way on the market. I recognize this, and have called attention to it in my paper. The fact remains, however, that no lubricant will work well in an improperly designed bearing, and almost any lubricant will give satisfaction in one that is properly designed. By all means, call the students' attention to the properties of lubricants, but do not make them the dominant theme.

Professor Norton has pointed out that the determination of the magnitude and direction of the load on a bearing is an important and essential part of bearing design. I heartily agree with him as to its importance. I should, however, classify the determination of bearing loads as a prerequisite to a study of the problems of lubrication. It belongs in the realm of mechanics. If the students taking up the study of lubrication do not know their mechanics well enough to obtain the bearing loads, they will, of course, be able to do nothing with the design of the bearing from the standpoint of lubrication. In that case, time will have to be taken to refresh their memories or to initiate them into the mysteries of bearing load determination.

Professor Norton mentions that the phenomenon of "oiliness" can be detected by means of the ZN/P diagram. I used to believe that this could be done, but within the last two years my faith in the diagram as a means of detecting "oiliness" has been shaken. The trouble comes from the fact that the diagram is plotted with the viscosity, Z, considered constant. The fact is, Z varies with

pressure, and at really high pressures may have a value well over one hundred times that at atmospheric pressure. If the ZN/P curve be plotted with values of Z corresponding to the pressure as well as the temperature, it will be found that low values of ZN/P cannot be obtained with high pressures. The points which on the ordinary curve lie in the branch to the left of the minimum move over and occupy positions on the right hand portions.

I am not prepared to say that this is the only cause of the upturn of the left hand branch. It seems certain that it is a sufficient one. This incident serves to illustrate what I had in mind when I warned against treating boundary lubrication with the same certainty with which we may treat thick film lubrication.

CIVIL ENGINEERING PAGE

Notes of interest for members of the Civil Engineering Division.
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A SURVEY OF THE METHODS OF TEACHING AND OF THE VALUE OF UNDERGRADUATE THESIS WORK*

BY W. M. LANSFORD

Assistant Professor, Department of Theoretical and Applied Mechanics, University of Illinois

The subject of undergraduate theses is of much interest to this Society if one may judge by the several papers presented at the recent past meetings. Because of this apparent interest, the Chairman of the Committee on Applied Hydraulics appointed a subcommittee to make a survey of undergraduate thesis work and to report the findings to the Society.

In this survey a questionnaire was sent to 139 engineering colleges. Replies were received from 102 institutions or approximately 74 per cent.

The author wishes to acknowledge the help of the members of the subcommittee, Professors Switzer, Lenz and Hutchison, who assisted in composing the questionnaire.

A brief summary of the results of the survey is shown in Table 1.

TABLE 1

SUMMARY OF REPLIES TO QUESTIONNAIRE

Number reporting theses offered	50
Number reporting no theses offered	41
Number reporting no theses offered but special problems are offered	11

Letters frequently accompanied the questionnaires returned, giving much valuable information concerning general policies in the various institutions and details of administration of thesis work that were not covered by the ques-

* Presented at S. P. E. E. Civil Engineering Division Conference on Applied Hydraulics at State College, Pennsylvania, June 1939.

tionnaire. The course in special problems while not a thesis course is used by some colleges instead of thesis work, because it does not require as much time or expense and it is thought the student receives some of the benefits which may be derived from thesis work.

Few schools have scholastic prerequisites for undergraduate thesis work other than senior standing and faculty approval.

The credit for thesis work varies from 1 to 20 hours, averaging about 6 hours, among the 50 schools offering such courses.

Theses are required of all senior engineering students in 14 colleges, or approximately 30 per cent of the 50 institutions offering such courses and are elective in 15 of the remaining 36. In the other 21 schools various departments of the college require their students to present theses while other departments within that college do not. Students are permitted to substitute thesis courses for any required course in only 3 per cent of the 50 schools but may substitute theses for elective courses in over 90 per cent of the 50 schools.

The 50 colleges offering thesis work represented 5,000 senior students in engineering in 1937–38 and approximately 5,300 in 1938–39. The records show that one out of every three or four of these students took a thesis course. The reports of the 37 colleges offering theses in hydraulics show 63 theses in hydraulics in 1937–38 and 74 such theses in 1938–39 or approximately one thesis in every 21 is a thesis in hydraulics.

The number of theses one instructor supervised varied from one to ten. In many schools no allowance for thesis work was made in the teaching load of those instructors directing theses. However, some colleges reported that allowance was made in the teaching load of instructors directing theses on the credit hour basis the same as in laboratory courses.

The faculty and administration of 22 colleges definitely encourage thesis work. Two colleges are removing the requirement for all seniors to take theses in 1939–40, and one other in 1941–42. Another school which had not previously offered theses intended to offer such work next year, 1939–40. A lack of sufficient funds to carry out thesis work was reported by 16 colleges, and this fact was mentioned by several schools as the chief reason why thesis courses were removed from the list of courses required of all senior engineering students. Seventeen of the 50 schools offering theses reported that this type of work was not retarded at their institution by lack of finances.

Nearly all the questionnaires reported that the faculty looked on thesis work mainly as a means to develop initiative and resourcefulness on the part of the student working independently and not as another course for intellectual discipline. Over 75 per cent of the 50 colleges reported that a critical analysis or interpretation of another's work was not a suitable thesis subject. However, over 80 per cent thought a design problem was a suitable subject. The questionnaire indicated that, in general, the problems selected for thesis investigations should be those whose solutions are unknown and for which the instructor and particularly the student are keenly interested in obtaining a solution. Also, usually there should be rather close contact between student and instructor concerning the thesis work.

Approximately 85 per cent of all the undergraduate theses required both theoretical work and experimental verification. The number of theses requiring only theoretical or only experimental work was about equal, each being approximately 5 to 10 per cent of the total number. The time used by the student building apparatus, obtaining data, and writing the thesis varied a great deal among the 50 colleges, the average time being about 75 to 80 per cent spent in building apparatus and obtaining data and 20 to 25 per cent in writing the thesis.

In colleges which reported a rather large number of elective theses and strong faculty encouragement, considerable coöperation was reported between the college and some outside agency such as industry or public works. It is to be noted that colleges offering theses in many fields of study reported much activity in all fields.

There is much to be said both for and against undergraduate theses, as evidenced in the papers previously presented to the Society, and it is realized that no questionnaire can give the entire picture of such work. However, this survey does show that many schools believe they are doing excellent thesis work and where the thesis is elective, if encouraged by the faculty, many students are glad to obtain such training and to profit by it.

It is true that thesis instruction is expensive and that probably only a portion of the total number of students are capable of such work. Nevertheless, the student taking a thesis, as an elective particularly, gets the training of selecting his problem, finding the solution and the practice of putting that problem and solution in shape for someone to read and understand. The student receives somewhat extended practice in the analysis of a problem and in the synthesis of the elements into which it has been resolved. In the ordinary class room the daily chore of the student is assigned to him and all he needs to do is keep the pace, but in thesis work he sets the pace and is responsible for the job.

It is apparent, from this survey, that a great deal of thesis work is given and it would seem that the standards of achievement must vary considerably among the various departments administering these courses.

On the basis of the results of the questionnaire and of the author's personal experience teaching thesis courses, he is of the opinion that,

1. Thesis work should be looked upon as a privilege and restricted to selected students.
2. It should be considered a superior type of work for which adequate equipment and facilities should be made available.
3. The achievement of thesis work should be on a higher plane than can be measured by a certain number of credit hours.
4. The results of thesis work should be of real importance to engineering science or practice and not as a rule be a repetition of a problem whose solution is well known.
5. Thesis work should be a joint enterprise between instructor and student, in which the student's development comes in part from close association with the instructor and perhaps with other members of the staff.
6. Some allowance should be made in the teaching schedule of instructors who are actively carrying on thesis work.
7. An objective test of thesis work might well be the publication of the thesis or a portion of it in a technical journal or the oral presentation of the results of the thesis before a technical group or audience.
8. Thesis work carried out with this objective is a valuable stimulus in developing a faculty.
9. Theses as considered in these remarks require the continuous promotion and encouragement by those in responsible charge of administrative and teaching work.
10. If a high order of achievement in thesis work cannot be attained, it is doubtful if thesis work can be justified.

ENGINEERING ECONOMY NOTES

Engineering economy is that phase of engineering which pertains to the specifically advantageous use of dollars and cents in engineering works.

EDMUND D. AYRES, The University of Wisconsin, *Editor*

WHAT IS ENGINEERING ECONOMICS?

There seems to be confusion in the minds of those interested in this subject as to the aims and objectives of such work and study.

Many believe that the principal aim is to get a solution to a situation which at the same time is in reality a decision. Others desire a solution in only one segment of a situation. I do not believe that the attainment of such a solution is possible nor do I believe that it is a legitimate aim of a course in engineering economics.

Let us look realistically at our problem. Our graduates go out into industry in various capacities. Sooner or later they will have assigned to them a project to study and to report upon. This assignment is made to them by someone in authority. By virtue of this authority, this same person has also the authority and responsibility of making a decision. Please note that the responsibility of the junior engineer is not that of making a decision but of providing sufficient information to the person in authority so that *he* can make the decision. The decision which this person comes to is influenced greatly by the factual data which our junior engineer reports to him. Also, however, the decision is influenced greatly by the sum total of current events, and particularly by the environmental training, personal bias and inhibitions of the person making the decision.

It seems to me, therefore, that our problem is to provide the student engineer with a technique which he may use in the preparation of reports to his superior. This technique should be logical, orderly and systematic. The report in its various sections should reveal to this superior the information which he may wish to use in coming to a decision. Note that the decision is the result of the application of judgment on the part of the superior as he weighs the data and its relationships.

First of all, this writer believes that confusion exists in the mixture of what may be called the "economy" and financial aspects of a project. He believes that the separation of these view-points leads to clarification and understanding. He believes that the first step in the study of a project is to determine its economy without regard to the manner in which it is to be financed. In this stage the project lends itself to the truest comparison with other solutions or with some selected standard of reference.

The "economy" analysis calls for a factual analysis of the monetary values implicit in the problem. Seven principal factors of an economy analysis are required investment, estimated income, estimated operating costs, net return, economic yield, unit operating cost at various levels of capacity or production, and unit operating cost plus expected return on the investment at various levels of capacity or production.

Assuming that the project is found to be worth-while as a result of the economy study, is it advisable for other reasons? This calls for an intangible analysis. This is an evaluation of the facts concerning the project which it has been found impossible to express in concrete figures or money values. They are spoken of as intangible, irreducible or subjective factors. Some of these factors have to do with consumer, financier, government, labor, and community relations and with considerations of workmanship and even moral and ethical values.

The financial analysis is the next study to be made. The total investment required by the project having been determined in the economy study, the next step is to canvass the various means of financing the project. Among the possible methods will be found financing with funds owned outright, financing with borrowed funds (bond issues), and methods made available by the formation of partnerships and corporations.

It should be remembered in this connection that the financial analysis has to do with the ownership of the investment and the distribution of the return from income after subtracting the operating costs to the sharers in the ownership. Therefore, money provided by a lender is a part of the financial ownership and interest on these funds is simply the financier's share of the net return. It should also be remembered that the repayment of the principal of a loan is not a financial cost but merely a shift in the ownership from financier to promoter.

Lastly, in order that a decision may be made by the person assigning the problem to the engineer, it is necessary to compare the several results obtained in the several analyses. This is best done by means of an invention of Professor Fish known as an "In Favor of Analysis." This is nothing more nor less than the comparison

of the results obtained with some standards which have common acceptance or which exist in the mind of the person who makes the decision.

Thus it can be seen that our problem is not that of trying to get decisions but that of developing sufficient data from which decisions may be drawn. It is true, however, if the student makes the four analyses here suggested, he can make a decision in terms of his limited experience, knowledge and maturity. Hence there may be as many different decisions as there are students in a class, all of which may be right when this thesis regarding decisions is kept in mind.

I believe that the answer to "What is Engineering Economics?" lies in the development of a technique by means of which all of the factors in an economic situation are surveyed and evaluated for the purpose of providing the necessary information for that person having the authority and responsibility of making the decision.

CLARENCE E. BULLINGER,
The Pennsylvania State College.

ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*, University of Virginia

PUBLIC SPEAKING AT RENSSELAER

By HOMER H. NUGENT

Professor of Rhetoric, Rensselaer Polytechnic Institute

Some seventeen years ago, in response to a demand from students, a course in public speaking was started at Rensselaer. No credit was given, although a certificate was issued upon completion of the course. In spite of the fact that attendance was therefore optional, about forty students elected and completed the course.

Since that time the Department of English at Rensselaer, on the advice of graduates and with the full encouragement of its colleagues on the faculty, has expanded the work until today we devote to public speaking one-fourth of the time of the first three courses, and one-half of the time of the senior course.

Out of the experimentation attendant upon such rapid expansion, two general principles seem to have emerged: (1) that elementary courses should be adjusted to the immediate situations of undergraduate life; and (2) that advanced courses should be adapted to the situations likely to confront the student in his future professional practice. In either case the course should be concrete and practical.

Engineering students at Rensselaer ordinarily take four courses in English, all of which are prescribed. Of these the first three —a freshman course in composition, and two reading courses, one based on English and one on American Literature—are intended to build up proficiency in the basic techniques of expression which in the senior course can be applied to the problems of writing confronting the practising engineer.

Public speaking in the freshman composition course is adapted naturally to the problems of the freshman—not merely those problems growing out of the transition from school to college, but also those growing out of the new need for greater effectiveness in his

work if the student is to meet the greater demands made upon him by a college curriculum. Instead therefore of asking the student to speak upon conditions in Europe or the state of our own nation, situations which have only a collateral influence on him, we assign speeches about the personal problems which are confronting him at the moment.

Since the course involves writing a single paper of considerable length, the first speech generally assigned has to do with the topic upon which he is writing. By delaying this speech for two or three weeks, much of the stage fright attendant upon an initial speech is avoided, as the student has become so accustomed to talking about his subject informally from his seat in the classroom, that the novelty of standing up before the class is offset by his familiarity with the material.

Succeeding assignments will vary, but all of them will be of immediate interest and of a practical nature. In one section for instance, the problem attacked will be that of studying more effectively. Two weeks before the speech is to be made, each student will be given an experiment to carry out. One man may be keeping a time chart, accounting for every hour of his day, in an endeavor to discover when and how he may be wasting time. A second man may be investigating the effect of late afternoon athletic exercise upon the quality of his evening study. A third may be breaking up the habitual pattern of his day in an endeavor to find out whether he does his best work at five in the morning or twelve at night. In any case attention is centered upon the experiment; consequently when he makes his speech upon the results, he has the feeling that this is no classroom exercise, but a very practical problem in communicating knowledge. Incidentally, in addition to the results in learning to speak in public, an occasional freshman learns how to better the quality of the work he is doing in all of his courses.

The reading courses based upon literature, coming normally in the sophomore or junior year, or both, present opportunity for tackling other undergraduate problems. When public speaking was introduced into these courses, it immediately paid for itself, in the sense that although a quarter of the class time was devoted to public speaking, none of the content of the courses was dropped. In the past, recognizing that one of the problems facing the undergraduate is to build up an elementary knowledge of those literary works and persons without which the individual does not feel himself educated, instructors had lectured upon authors and their works. Under the new organization all of this work is turned over to the students, who dig out the material in the library and then present it to their fellows in a way most likely to interest them.

Other assignments also grow out of the students' problems. Nothing, for instance, infuriates a student more than to have someone read him poetry, and then tell him that either he must like it, or be considered sub-normal. He feels a great deal better if at the end of a week devoted to reading poetry, he can make a speech endeavoring to tell the world in general and his classmates in particular just why poetry is the bunk. In the process, indeed, he often persuades himself, or is persuaded by the speech of a classmate, that poetry is not so bad as he thought.

Problems in human relations present a wide scope of topics for speeches. A section that has been reading Hardy's "The Return of the Native," for instance, may have a series of speeches pointing out the successful way of entering a new community, or of meeting strangers singly.

In the senior course, which endeavors to apply the technique acquired in the elementary courses, one-half of the time is devoted to the study of writing reports and professional correspondence; the other half is given over to public speaking. Every speaking assignment is based upon an actual situation which may await the student in the practice of his profession.

Sooner or later he will find his voice being amplified electrically. To prepare him for that strange sensation of hearing a voice that is, and at the same time is not, his own, we take him to a large hall and have him speak with the public address system.

Everyone who has spoken over the radio has some recollection of mike fright. To prepare the student for this, every student is taken to the radio station, where under conditions approximating actual broadcasting, he delivers a short speech to which his classmates listen in the next room. The instructor will teach the student the proper procedure at the microphone, but his classmates will give him the best idea of what radio does to his voice. Incidentally, in the endeavor to approximate actual broadcasting, every student gets a chance to try his hand as an announcer. In this connection, it is interesting to note that several graduates have gone into professional announcing; and because of the age of the Institute broadcasting station, it has had longer experience in announcing than most of the big broadcasting companies.

In practical work of an advanced nature, we have found that the most valuable method is dramatization. One of the immediate problems before our seniors is the interview regarding employment. In one assignment, either the instructor or a student takes the part of the personnel man and interviews a student applying for a job. The various forms which this problem may take are worked out in detail. In one instance, the personnel man will tend to ramble, and it will be the specific task of the student to bring

him back to the purpose of the interview. In doing this tactfully and without giving offense, the student learns a great deal. In another instance, the personnel man will sit back and wait for the student to take the initiative. If the student is successful, the instructor and the class point out the reasons. If he fails, the others endeavor to show him how it could have been done.

Another assignment which has proved successful consists of having the class for one hour constitute a town meeting. The form of the problem will vary with the students. If they are studying to become mechanical engineers, it may be that the meeting will be considering the purchase of snow removal machinery. If they are civil engineers, it may be a water works system. In either case, some of the students will represent technical men who are trying to convince ordinary citizens, represented by the rest of the class. After an hour of this, a student will never have quite the same fear at the thought of having to convince a body of interested laymen of the importance of a technical proposal.

Narrowing the problem somewhat, we change the town meeting to the meeting of a board of directors. In one form, the class will become the business council of a firm, and certain members will represent employees in the technical departments who will endeavor to convince the board that it would be wise to buy an invention that has been submitted, or to spend more money than it wishes for new technical equipment. One very interesting assignment provides that the class represent the board of trustees of the Institute and decide what shall be done with the half million dollars just bequeathed (merely for the purpose of the assignment, worse luck!) with no strings attached.

One of the more successful assignments has to do with expert testimony in a court of law. Several students are given specific parts. One is the expert giving testimony; another is a friendly attorney; another is a hostile attorney; and a fourth is the judge. The evidence to be used will vary with the background of the students. A group of students in chemical engineering who have just completed a course in which toxicology was treated, will conduct a murder trial. With a group of electrical engineers, it may be a suit for damages involving an accident with high tension wires. A group of civil engineers will choose a case where the damages are sought because of the failure of a bridge or building. A group of mechanical engineers will choose a case involving a boiler explosion. It will be noticed that the students choose the specific material from a course or courses recently completed.

Working up the background for the trial is left largely to the students. At first instructors prepared elaborate directions, but we have found that because of their nearness to the material, students

are likely to be more skillful, and take a great deal of pleasure in working out the details. In addition, it gives them training in the use of the imagination, a training which will later stand them in good stead in such tasks as inventing hypotheses.

It is not of course possible to train a student in a single assignment so that he is fully equipped to give expert testimony. He can, of course, be given general hints, such as never appearing "smart," or appearing to recognize a victory he has scored over a hostile attorney. Fortunately it is not necessary to give him complete training. It will be enough if we dramatize the situation sufficiently so that if in the future he comes into court, he will feel that this is not entirely a new and therefore a terrifying experience. With such assurance he will have a better chance of keeping his head and helping his client.

It is apparent that we put much more stress on speaking assignments than on teaching the theory of public speaking. Seldom is a text in public speaking used in our courses. Believing that primarily one learns to speak by speaking, we develop what theory is necessary by giving the students definite and practical things to do. Thus a student is told to open his mouth wider when speaking; and it is only when he asks why, that an explanation of pharyngeal resonance is given him. Incidentally he always does ask why.

We have found that there is little need for teaching theory formally, if we keep a student speaking upon subjects which he recognizes are closely related to those problems facing him now, and to those which may face him when he becomes a practising engineer.

MECHANICAL ENGINEERING PAGE

Those who personally dominate are heroes for the hour; those who build men are immortals.

R. L. SWEIGERT, Georgia School of Technology, *Editor*

SHOP, DRAWING, AND DESIGN COURSES FOR ENGINEERING STUDENTS

By A. L. TOWNSEND

Massachusetts Institute of Technology

Engineering design in some form is the basic reason for the inclusion of drawing and the so-called shop courses in an engineering educational program.

Why are design courses necessary? It admits of no argument to say that an overwhelming majority of engineering graduates are in jobs which have to do with some phases of machinery. The term "Machinery" is used here in its very broadest sense to include a bridge, an electric generator, an internal combustion engine or a rayon spinning machine, etc. Loosely speaking, the graduates' activities may be subdivided something like this:

(1) Purchase or supervising the purchase of machinery.
(2) Install and utilize equipment or supervise this work.
(3) Sell or distribute such equipment.
(4) Manufacture such equipment.
(5) Actually design such products.

To work intelligently in any of these fields, a good knowledge of engineering design is invaluable, and in most cases is essential. To have a good grasp of the fundamentals of engineering design (besides the usual basic courses of mathematics, physics, applied mechanics, applied electricity, etc.), it is quite necessary that the graduates have a good background in materials and their uses, the working of materials by all sorts of processes, and the limitations of the various shop and field tools and equipment used in materials processing. Besides all these, the graduate cannot design intelligently unless he knows the language of design and can express his ideas clearly, by picture or word. By picture we mean the careful use of sketches and drawings which convey the appropriate and correct amount of information.

There are other important reasons why Engineering Design is essential. They may be roughly listed as:

(*a*) To develop process of analysis.
(*b*) To emphasize the wide investigation often necessary in making a design.
(*c*) To show the relationship to design, of such factors as manufacturing difficulties, costs, useful life, etc.
(*d*) To develop logical methods of attack on comprehensive engineering problems.

(*e*) To provide an opportunity to bring together in one course and even in one problem most all of the basic and preliminary subjects studied in previous courses and years.

Many investigations have been carried on during the past ten years, by many agencies, relative to the destination of engineering graduates. From the Bureau of Labor one report shows the following distribution of mechanical engineering graduates:

Design and Research	33.8%
Construction	9.6
Operating	25.9

The rest are scattered among teaching, sales, management, consulting, etc.

If we may generalize upon these data, they show that the jobs held by a large majority of graduates require a general knowledge of Design and all that it implies. Other responsible agencies have undertaken similar surveys in Mechanical and other engineering branches with essentially the same results.

Admitting the foregoing, next comes the problem of the so-called shop courses. I dislike the term shop for present-day use. Years ago most of our material processing laboratories were operated on the trade school idea, and were in every sense, shops. No attempt was made at orderly systematic methods of instruction. A common practice was to make or build a small machine, for commercial sale, for the practice involved, letting the individual processes come as they would. In some cases this procedure continued altogether too long, so that shop courses as a whole were severely criticized, and justly, so for wasting time and equipment without producing satisfactory results. With these unsatisfactory conditions, it was obvious that a large number of educational administrators were firmly convinced that all of this work could be given just as well, if not better, by industry, and that students needing this work should get it by summer employment or by going into the shop immediately upon graduation.

Some forty years ago, the late Professor Robert H. Smith then a young instructor in the Machine Shop at the Mass. Inst. of Tech. decided that the whole instructional scheme, as then employed, for such work was all wrong. He was the pioneer in this idea, in which the so-called shops should be elevated in dignity and placed on a par with the laboratories of Physics and Chemistry and with the drafting rooms. He decided that the way to teach the things which should be taught, was to emphasize processes and materials to the almost complete elimination of the "project" idea. That is to say not to build something for the sake of building it and letting the methods and processes be secondary, but to reverse the idea. Professor Smith emphasized the limitations of the various machines at his disposal and impressed upon the students the relation of tool and materials to effective machinability. Upon these general principles, for some forty years, the laboratories not only at the Massachusetts Institute of Technology, but at many other schools as well, have operated. Of course, new ideas and new methods are constantly entering the scheme with the hope that we are ever improving the product; namely the student's better understanding of materials processing.

Similar comment might be made about the transformation of the foundry and forge shop into laboratories of cast and wrought metals with metallurgy receiving its proper attention.

If we are to have laboratories of Physics and Chemistry in connection with lectures and recitations, we are fully justified in having mechanical processes laboratories placed on this level and conducted with the same amount of dignity and operated under the same philosophies.

The extent to which these Mechanical Processes laboratories may flourish in different schools depends upon many items. A few of them may be:

(*a*) Space available
(*b*) Equipment available or procurable
(*c*) Number of students to be handled
(*d*) Staff available
(*e*) Time allottment in the course of studies, and lastly, but the most important,
(*f*) Budget recognition.

No hard and fast set of rules can be formulated, but it is generally admitted that the most efficient use of a student's time is by orderly, well prepared and systematic instruction under the laboratory method, something not always available in the commercial production shops of industry.

One report from nearly 1,000 practicing (general) engineers shows agreement that:

(1) Shop should be given in mechanical and electrical engineering.
(2) Summer employment should not be substituted for shop work in college.
(3) Knowledge of general principles is of primary importance, and skill entirely subordinate.
(4) Lecture-laboratory method was preferred to any approximation of commercial products methods.

The Armour Institute Report of 1935 under the authorship of Professor Finnegan is even more conclusive. A brief summary shows that a vast majority of college deans, Armour's own alumni, and employers in general are decidedly in favor of shop courses for mechanical and electrical engineering students to be given in the schools' own shops. A fair majority express the same opinion for chemical engineers. For civil engineering, the trend is definitely no.

Now for the third item under discussion, namely drawing. Engineering drawing is the language of the engineer. All engineering work begins and ends on the drafting board. Anyway, all engineering work at some stage of its career is prosecuted on the drafting table. It is, therefore, important that all engineering students have a basic knowledge of the principles of engineering presentation by drawings. If proper emphasis is placed upon this subject, and is handled in the correct manner, the student acquires a knowledge and facility which will be a part of his nature equal to, if not of higher quality and value, than his spoken and written word. He will be able to increase his ability and facility so that as he progresses with his more advanced engineering work he makes neat and orderly sketches and drawings, in keeping with the accepted practice, and does so without conscious effort. Not only should this be emphasized in his drawing courses, but should be insisted upon by instructors in all other departments and subjects.

There is another argument in favor of well organized and presented drawing courses. In most schools, these courses are given in the first year, and in many cases extending to the second year. This work is often the student's first contact with engineering terms and with simple engineering problems. The impact upon first year students of the transition from secondary schools to technical schools is heavy and in many cases is overwhelming. The drawing instructor has a wonderful opportunity to ease this blow and guide the student into this college atmosphere and environment. Individual instruction at the drafting table gives unparalleled opportunity to become acquainted with the individual student, and learn of his background, tastes, troubles, ambitions, etc. The drawing instructor can be a powerful influence in student guidance and orientation. Proper

instruction in the drafting room under not only competent but sympathetic teachers can do worlds of good toward getting the young student into the correct frame of mind to face his other problems. This non-technical side of the drafting room is of equal importance and in many cases has a more lasting benefit. There is ample room for this extra curricula influence.

Drafting rooms require much space and should be the best lighted and ventilated in a building. Equipment for shop courses is expensive to acquire and maintain, and also requires a lot of well-lighted space. These facts constitute the vulnerable points in the scheme of life of drawing and mechanical processes courses. Since the work done here is of a less spectacular nature and of little publicity value, budget control officers are prone to direct excess funds to other work leaving drawing and shops little for improvement or expansion. To combat this arrangement, drawing and shop teachers must take on a new lease of life and put more enthusiasm into their work, if for no other reason than to impress their superiors. By this method the quality of work will improve and the students will receive a lasting benefit.

There is a slowly increasing group of young brilliant mathematicians on our engineering faculties. This is as it should be. On the other hand, a number of these men feel that the differential equation is the back log of engineering education, and will eventually replace all of the intangibles acquired in drafting room and mechanical processes courses. Emphasizing the importance of their own mathematical background, they feel, and perhaps justly so, that drafting and shop courses are logical places to attack, to gain more time for the mathematical treatment of their own subjects. Unless these courses are conducted in the most efficient manner possible, we may find that the time allotted to these subjects will slowly but surely be compressed to extinction. I think it is necessary for all to give the utmost attention to the course handling of the subject matter under discussion and that we fortify ourselves in fields of mechanical, electrical or general engineering against the attacks of the mechanical or electrical scientist.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

A. W. LEIGHTON, *Editor*, Tufts College

DEVELOPMENT OF CHARACTER AND INITIATIVE IN THE DRAFTING ROOM

We teachers hear the cry occasionally that engineers just out of college lack interest in drafting, yet drafting is that activity in which the graduate can most clearly coördinate the elements of his engineering training. In the drafting room he can follow the processes of manufacture mentally; he can see his ideas shape themselves into reality; he can note the uses of various materials, the mechanisms by which particular motions are accomplished and the adjustments and compromises necessary to balance costs against performance. He can observe the metamorphosis of an idea into a device which will perform its function gracefully. He can note the relation the machine bears to the lives of those who come in contact with it.

Life in a drafting room is not a bare one devoted to routine. The draftsman can combine his drawing skill with his intelligence to yield for himself a most pleasurable living. As teachers having known that life, we should be able to pass on to our students the realization that the drafting room is a delightful avenue towards their goals as engineers.

The schoolroom should possess some of this spirit of creating. There are a variety of ways in which this may be accomplished. The instructor may illustrate with his own experiences the type of work which may be met in the industrial drafting room, and thereby picture quite vividly the activity and romance that exists there. The most interesting intellectual pursuits are those which watch and assist growth, whether that growth pertain to a child, a flower, a building, a mathematical solution, or an idea. Note the interest in a student's eyes when a teacher relates the story of an engineering problem and its solution.

It is not enough, however, to paint glowing pictures of engineering successes; we must give the student a chance to follow through with a problem of his own. In my classes each semester I place in the hands of a small squad the job of drawing a small practical project. For example, one semester a set of hangers for a large polyphase slide rule was designed and then built by a shop class. The progress of that design yielded a final product totally different from the initial idea, and although it was a small project, it was alive with problems. To further develop interest, each student is required to make a patent drawing of an object of his "own invention"—he does not merely copy or revise an existing drawing. Often he will throw up his hands in despair at this suggestion, but a discussion of the many improvements that might be made in objects about him will start his mind working and his enthusiasm to mount

high. In the end, not a single student will fail to find an "invention" of his own.

The student should be permitted to see the instructor at work on drawings. He will be inspired to match his teacher, line for line. Let him see samples of drawings made by professional draftsmen—industrial drawings are interesting when explained in terms of technique, presentation, and informative value. The myth of poor eyesight and confined activity should be destroyed whenever possible, as should the idea that he cannot progress beyond the drafting room if he starts there.

All in all, the student deserves an environment of optimism and interest which will not only give him a truer picture of the field, but will serve to lead him personally toward a richer, fuller life.

F. PAULSEN,
Mathematics—Engineering Department,
San Mateo Junior College.

NEW MEMBERS

BENGTSON, NELS A., Dean, University Junior Division, Professor of Geography, University of Nebraska, Lincoln, Nebr. J. W. Haney, O. J. Ferguson.

BISHOP, WALTER W., Assistant Personnel Director, Wright Aeronautical Corp., Paterson, N. J. P. H. Daggett, F. H. Pumphrey, N. P. Bailey.

CAMPBELL, JOHN SCOTT, Instructor in Engineering, Pasadena Junior College, Pasadena, Calif. A. G. Gehrig, R. W. Sorensen.

CARR, HENRY M., Assistant Professor and Head, Dept. of Industrial Engineering, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

EARNEST, G. BROOKS, Assistant Professor of Civil Engineering, Case School of Applied Science, Cleveland, Ohio. Re-admission.

ELROD, STEPHEN B., Assistant Professor of Engineering Drawing, Purdue University, Lafayette, Ind. Justus Rising, C. W. Beese.

FLOYD, COLUMBUS, Instructor in Mechanical Engineering, Tulane University, New Orleans, La. A. M. Hill, J. M. Robert.

GIBSON, ROBERT, Assistant in Electrical Engineering, University of Illinois, Urbana, Ill. H. J. Reich, H. N. Hayward.

GILBERT, WILLIAM W., Professor of Metal Processing, University of Michigan, Ann Arbor, Mich. W. J. Thompson, A. H. White.

HARTLEY, LODWICK C., Professor of English, North Carolina State College, Raleigh, N. C. B. R. Van Leer, J. W. Cell.

HEIN, JAMES M., Assistant Professor of Engineering Drawing, University of North Dakota, Grand Forks, N. D. Irvin Lavine, L. C. Harrington.

HIGBIE, RALPH W., Assistant Professor of Chemical Engineering, University of North Dakota, Grand Forks, N. D. Irvin Lavine, A. M. Cooley.

KRAEHENBUEHL, JOHN O., Professor of Electrical Engineering, University of Illinois, Urbana, Ill. H. W. Horn, H. H. Jordan.

LACY, EDGAR W., Instructor in English, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

MANNING, MELVIN L., Research Engineer, Secretary, Education Com., W. E. & M. Co., Sharon, Pa. E. A. Holbrook, F. L. Bishop.

MAUGH, LAWRENCE C., Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. C. T. Olmsted, J. A. Vanden Broek.

MEADE, KENNETH A., Director, Education-Training, Research Laboratories Div., General Motors Corp., Detroit, Mich. A. M. Greene, J. C. Elgin.

MIDGETTE, ERNST L., Assistant Professor of Machine Design, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. N. P. Bailey, W. C. Schulte.

NUNAN, JAMES K., Instructor in Electrical Engineering, University of Southern California, Los Angeles, Calif. P. S. Biegler, T. T. Eyre.

ORDON, CHESTER J., Instructor in Civil Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. L. F. Rader, H. R. Codwise.

REUKEMA, LESTER E., Associate Professor of Electrical Engineering, University of California, Berkeley, Calif. C. F. Dalziel, B. M. Woods.

SCHELL, ERWIN H., Professor of Business Management, Massachusetts Institute of Technology, Cambridge, Mass. K. T. Compton, J. R. Killian.

SMITH, JAMES O., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. F. B. Seely, W. M. Lansford.

SPURLOCK, BENJAMIN H., Teaching Assistant in Mechanical Engineering, University of California, Berkeley, Calif. M. P. O'Brien, C. F. Garland.

UPTHEGROVE, CLAIR, Professor of Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. A. H. White, E. M. Baker.

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COLLEGE NOTES

Lehigh University.—Loyal V. Bewley, of Pittsfield, Mass., research engineer with the General Electric Co., has been appointed Professor of Electrical Engineering and head of the department, succeeding the late Professor Stanley S. Seyfert. His appointment is effective September 1, 1940.

In 1923 Mr. Bewley graduated in electrical engineering, *cum laude,* from the University of Washington, and at once entered the employ of the General Electric Co. He completed the "Advanced Course" of that company, and in 1928 received the degree of Master of Science from Union College. He is a member of Tau Beta Pi, Sigma Xi, and the American Institute of Electrical Engineers.

Not only has Mr. Bewley had a wide range of design and research experience during his 17 years with GE, but he has taught almost continuously in the courses for engineering graduates sponsored by that company. For eight years he taught the General Course at Pittsfield, and also has given courses in Operational Calculus, Electromagnetic Theory, Traveling Waves, High Frequency Transients, etc. He is the author of the book on "Traveling Waves on Transmission Systems," and of many papers and reports.

The Physics Department of the **University of Pittsburgh** announces the following special graduate courses to be given in the summer session, June 17 to July 26.

Physics of Metals:

Introductory Electron Theory of Metals—Lee A. DuBridge, University of Rochester.

Recent Experiments with Metals—R, P. Johnson, General Electric Company.

Electrical Properties of Metals—W. V. Houston, California Institute of Technology.

Theories of the Plastic Properties of Metals—Frederick Seitz, University of Pennsylvania.

X-Ray Diffraction and Structure of Matter—B. E. Warren, Massachusetts Institute of Technology.

Experimental Research in X-Rays—S. S. Sidhu, University of Pittsburgh.

Physics of Glasses:

Structure of Glass—B. E. Warren, Massachusetts Institute of Technology.

Nuclear Physics:

Nuclear Physics—Lee A. DuBridge, University of Rochester.

Experimental Practice in Nuclear Physics—A. J. Allen, University of Pittsburgh.

Seminar in Nuclear Physics—Conducted by E. U. Condon, Westinghouse Research Laboratories.

Schedules of courses and further information regarding these courses may be obtained by writing to the Head of Physics Department, University of Pittsburgh.

THE ENGINEERING SOCIETIES LIBRARY *

The Engineering Societies Library has made available at cost not only photostats, but also microfilm copies of material contained in the 160,000 volumes and thousands of periodicals in its collection. Regardless of residence, any engineer, library or company may order an 11 ×14-inch white-on-black (negative) photostat print on bromide paper at 30 cents each, which charge includes ordinary postage to any part of the world. Black-on-white (positive), prints are supplied by copying a negative print, which makes the cost 30 cents additional. Microfilm copies on 35-mm. film are available at a cost of four cents per exposure (usually one page), with a minimum charge of $1.25 per volume.

Each photostat print contains one or two pages of the original article, depending on its size. Reductions to approximately one half or enlargements to twice the original size can be made, if desired, without any extra charge. Unless an enlargement or reduction is specified, prints are made the same size as the original.

For the benefit of those who can come to the library in person, a trained staff stands ready to assist them in their problems. Despite the fact that it is the official library of national engineering societies, all books and periodicals are available for the free use of the public during regular hours. If a translation or list of references on any particular subject is desired, the library staff will prepare this at cost. For those wishing to photograph material in the library, the photographic coyping stand, complete with table and electric lights, is available for use with the visitor's own camera.

* The library is a joint coöperative enterprise of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

SECTIONS AND BRANCHES

The **Allegheny Section** of the Society will hold its sixth annual meeting at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, on Friday and Saturday, October 25 and 26, 1940. The theme of this meeting will be "The Coördination of Engineering Curricula." The Engineers' Council for Professional Development is meeting in Pittsburgh on Thursday 24, 1940, and its members have been invited to attend the Allegheny Section meeting.

Friday afternoon—The Theatre, College of Fine Arts.

Address of Welcome by Robert E. Doherty, President, Carnegie Institute of Technology.

Fundamentals of Professional Education by Elliott D. Smith, Master of Saybrook College, Yale University.

The Scientific-Technological Stem of Engineering Education by William E. Wickenden, President, Case School of Applied Science.

The Social-Humanistic Stem of Engineering Education by Willard E. Hotchkiss, Maurice Falk Professor of Social Relations, Carnegie Institute of Technology.

Discussion

Tea, The Exhibition Room, College of Fine Arts

Friday evening.

Banquet, Boggs and Buhl Dining Room.

Toastmaster: Dr. Robert E. Doherty.

Address: People Still Reach for the Stars by Charles F. Lewis, Director, The Buhl Foundation.

Inspection of the new Buhl Planetarium to be followed by a special performance in the Theatre of the Stars.

Saturday morning—The Theatre, College of Fine Arts.

Coördination of Industry with Engineering Colleges by Walther Mathesius, Vice President, United States Steel Corporation.

Coördination of Liberal Arts and Engineering Education—3-2 Plan by William P. Tolley, President, Allegheny College.

Coöperative Engineering Education by Douglas F. Miner, George Westinghouse Professor of Engineering, Carnegie Institute of Technology.

Discussion

Saturday afternoon.

Football game—Case vs. Carnegie Tech—The Stadium.

Social hour—University Club.

Saturday evening.

Special performance to be given by the Drama Department of the Carnegie Institute of Technology, The Theatre, College of Fine Arts.

J. B. ROSENBACH,
Secretary.

The **Michigan Section** of the Society held its Fourth Annual Meeting at the University of Michigan beginning at 2:00 P.M. on Saturday, April 27.

M. E. Coyle, General Manager of the Chevrolet Division of the General Motors Corporation and Vice-President of General Motors, delivered an address on the subject "Let Us Look At American Industry." Eugene B. Elliott, State Superintendent of Public Instruction, followed Mr. Coyle's address with a discussion on "High School Curricula."

At the Michigan Union at 6:15 some 151 sat down to dinner. Later James D. Bruce, Vice-President of the University of Michigan, welcomed the members and their ladies and introduced the new Dean of Engineering at the University of Michigan, Ivan C. Crawford, formerly Dean of Engineering at the University of Kansas and who succeeds the late Henry Anderson. Dr. Crawford spoke on "Modernizing the Engineering Curriculum."

Officers of the Executive Committee elected at the meeting are as follows:

Chairman: Lorin G. Miller, Michigan State College.
Vice-Chairman: Ray A. White, Grand Rapids Junior College.
Secretary: C. C. Winn, Detroit Institute of Technology.

Edward L. Eriksen, University of Michigan, presided at both the afternoon and evening sessions.

At the annual meeting, **Ohio Section,** S. P. E. E. held at Fenn College, April 20, the following were elected officers of the Section for 1940-41:

Chairman: R. C. Gowdy, University of Cincinnati.
Vice-Chairman: E. E. Kimberly, The Ohio State University, T. C. Lloyd, Robbins and Myers Co., Springfield, Ohio.
Secretary: Sada A. Harbarger, The Ohio State University.

SADA A. HARBARGER.

The eighth annual meeting of the **Pacific Northwest Section** was held April 19–20, 1940, at the Oregon State College,—attendance 69. The convention was opened with an informal dinner in the Memorial Union Tea Room. At the conclusion of the meal, President C. A. Mockmore opened the meeting by introducing Dean R. H. Dearborn who welcomed the delegates to Oregon State College. Deans Loew and Buchanan, and Professor Parker then introduced their respective delegations by having them rise.

A report on the 1939 national meeting of the society at Penn State College was made by Professor E. B. Parker of W. S. C. This oral report covered the high lights of the convention, and the conduct of the national officers.

President Mockmore appointed the Nominating Committee consisting of E. B. Parker of W. S. C., J. E. Buchanan of U. of I., and E. R. Wilcox of U. of W., as chairman.

G. W. Gleeson, Head of Chemical Engineering at Oregon State College addressed the convention on "The Manufacture of Aluminum." The address was followed by two reels of sound motion pictures on the production and fabrication of aluminum, prepared by the Aluminum Company of America. The subject proved to be of much general interest to the group, due to the establishing of a refining plant at Vancouver, Washington, by the Aluminum Company of America, to use Bonneville Power.

J. C. Othus presided at the technical session. A. L. Miller of U. of W. gave an oral discussion of his paper "A Contemplation of Engineering Mechanics Courses." Written discussions were presented by E. B. Moore, W. S. C., A. S. Jannson, U. of I., I. F. Waterman, O. S. C., and C. H. Holleman and R. T. Challender, M. S. S. In the absence of the Montana State College representatives their discussions were read by Professor C. E. Thomas of O. S. C.

The delegates assembled in the Memorial Union Tea Room for luncheon which was followed by a business session with President C. A. Mockmore presiding. Dean J. E. Buchanan invited the Section to meet at Moscow, Idaho, for their 1940 convention. The invitation was accepted by unanimous vote. The Nominating Committee then presented the following nominations for officers for the coming year, who were unanimously elected:

President: J. H. Johnson, U. of I.

Vice-President: O. E. Osburn, W. S. C.

Secretary-Treasurer: A. J. Davidson, U. of I.

Attention of the convention was called to the recent death of one of our members, Professor Ike N. Carter of the University of Idaho. The secretary was instructed to write a letter of sympathy to his widow.

The afternoon was spent in small departmental groups conferences held in the laboratory buildings of the Engineering School. These conferences included Civil, Electrical, Chemical, and Mechanical Engineering as well as one which continued the discussion of the teaching of Mechanics.

The delegates gathered in the evening for an informal dinner at the Benton Hotel. After the meal Dean R. H. Dearborn, O. S. C., presided and introduced two engineering students of the college who entertained the group with music. Robert Bruns, junior in Electrical Engineering, played several numbers on the piano and Vern Satter, sophomore in Civil Engineering, sang several baritone solos, accompanied on the piano by Miss Iris Gray.

Dean Dearborn then presented John E. Sloan, Cal. F. A., U. S. A., who gave a masterly discussion of "America and National Defense."

The annual meeting of the **Rocky Mountain Section** was held at the University of Colorado on May 4, 1940, with W. O. Birk, chairman, presiding, and 54 in attendance. The meeting was opened by words of welcome from Dean H. S. Evans and President R. L. Stearns. A letter was read from President O. J. Ferguson, in which he sent greetings to those present and expressed the regret that he was unable to attend.

Professor Harl R. Douglas, head of the Department of Education at the University of Colorado, presented a paper on "Some Factors Related to Scholastic Success in the Study of Engineering." This study was made by Professor Douglas at the University of Minnesota for the Board of Admissions. A set of tests, designed to measure a student's capacities rather than his specific knowledge, was used to supplement high school records, ancestry, etc., in making an early selection of those students most likely to succeed. The coefficients of correlation were very encouraging.

Professor A. S. Adams, Colorado School of Mines, in his talk on "Entrance Requirements," divided the qualifications of an entering student into three classifications. The first two which are objective and measurable are the individual's capacities and his preparedness in specific subjects. The third which is subjective, is interest, which was referred to as the spark which fires capacity.

The afternoon session consisted of a panel composed of Dean N. A. Christensen, Colorado State College, Dean R. D. Goodrich, University of Wyoming, Dean R. E. Nyswander, Denver University, and Professor William Hume, University of New Mexico. Professor Hume was unable to attend the meeting but prepared a paper which was read by Professor Warren Raeder, University of

Colorado. The theme of this panel was "Reconstructing the Engineering Curriculum," and had for a background the recently published proposal of D. B. Steinman, and the report of Dean Hammond's committee. Subsequent discussion from the floor resulted in the adoption of a resolution admonishing engineering instructors so to broaden their existing courses by their own study along cultural lines, that the students would be inspired in this direction. It was generally believed that such a policy, if carried out, would obviate the making of any major changes in the curricula.

The following report, submitted by the nominating committee was unanimously adoped:

Denver University—Host for 1941.
R. E. NYSWANDER—Denver University—*Chairman.*
CHESTER RUSSELL—Denver University—*Secretary.*

HARLAN B. PALMER,
Secretary.

NECROLOGY

LEWIS VAN CARPENTER, professor of sanitary engineering in the New York University, died of heart disease, May 10, 1940. One of the leading sanitary engineers of the nation Professor Carpenter had been ill since last November. At that time he was directing an important and large scale investigation of land fills in coöperation with the New York City Department of Sanitation and the Works Progress Administration.

Appointed to the staff of the University in 1935 Professor Carpenter was not only active in teaching and research work but a leader in the development of "short schools" for municipal plant operators in sanitary engineering and allied fields.

Born in Wheeling, West Virginia, in 1895, Professor Carpenter attended the University of his native state where he received the degrees of bachelor and master of science in civil engineering. In 1926 he attended the University of Illinois where he was awarded the M.S. degree in sanitary engineering.

Appointed to the faculty of the University of West Virginia as an instructor in 1923; professor of sanitary engineering in 1929 and three years later was appointed chairman of the department of civil engineering, a post he held until his transfer to New York University.

HENRY HUTCHINSON NORRIS, supervisor of personnel and special instruction, Boston Elevated Railway, Boston, Mass., died April 14, 1940. He was born April 26, 1873, at Philadelphia, Pa. He studied electrical engineering at Johns Hopkins University, where he received in 1894 a diploma as "proficient in electrical engineering," no engineering degree being given there at that time, and at Cornell University, where he received the degree of mechanical engineer in 1896. He was engaged in electrical work for various companies 1890–94. In 1896 he became an instructor in electrical engineering at Cornell University, Ithaca, N .Y., in 1901 assistant professor, in 1905 professor, and from 1909 to 1913 was head of the electrical engineering department. In 1913 he became associate editor of the *Electric Railway Journal*, McGraw-Hill Publishing Company, New York, N. Y., in 1921 managing editor, and in 1923 assistant to the president of the McGraw-Hill Company. A short time later he became educational advisor to the Boston Elevated Company, Boston, Mass., continuing with the company until his death.

Mr. Norris was Secretary of the Society for the Promotion of Engineering Education from 1909 to 1914; Vice-President in 1914–15.

BOOK REVIEWS

Lattice Girder Bridge. H. P. PHILPOT. Longmans, Green and Company, New York. 1939. 223 pages. Price $2.60.

In this text the author, Professor of Technology, Engineering College, Benares, India, designs a Pratt, single-track railroad bridge having a span of 156 feet.

Since the work is limited to the one subject, its use as a textbook could not be general. But it is of definite value as a reference because of the completeness, continuity, and clarity of the work. Often students and young engineers are confused when confronted with the problem of designing a bridge because the information he needs may be widely scattered.

The book is, of course, British in style; and the specifications and nomenclature used are either British or Indian. It is a worthwhile addition to the engineering library.

M. L. RUTTER

The Theory and Practice of Reinforced Concrete. CLARENCE W. DUNHAM. McGraw-Hill Book Company, New York. 1939. 529 pages. Price $4.50.

One of the best recommendations for this book is its large and growing adoption in a field in which there are many good books, even though it has been available for only one year.

The author has had excellent experience in reinforced concrete theory and practice because of his work as Civil Engineer for the Port of New York Authority.

The text is made very alive to the student by its direct contact with actual construction work. There are a great many figures and illustrations taken from actual structures. These features help to keep the study of reinforced concrete from becoming the dry, uninteresting course that it too often is.

The writer has done an excellent job of presenting the fundamental material necessary for concrete design. The chapter headings will give an indication of the thoroughness of this text: Properties and Manufacture of Concrete, Stresses in Beams due to Bending, Bond, Shear and Web Reinforcement in Beams, Composite Beams, Columns, Combined Bending and Direct Stresses, Retaining Walls, Foundations, Miscellaneous Structures, Analysis of Rigid Frames by the Method of Work, Arches, Analysis of Rigid

Frames by Moment Distribution, Building Frames, Architectural Considerations, Practical Details and Miscellaneous Data.

The author states that the first six or seven chapters are intended for use in an elementary course in the design of reinforced concrete; the rest of the text is designed especially for the benefit of the practicing engineer and for use in advanced courses. It is unquestionably one of the best books of its kind.

M. L. RUTTER

Elementary Surveying. WARREN C. TAYLOR. Published by International Textbook Co. 236 pages.

This is a recent effort to write a small book suited for elementary courses in surveying and has faced the usual difficulty of books of this type in being limited in size and content. The author has made a splendid attempt to present only essentials and with but a few exceptions he has succeeded admirably. The most valuable non-essential in the text is the presentation of the historical background of our present methods of surveying. This information is novel in books of this type and should prove to be of value in arousing the interest of the student.

The essentials of surveying; measurement of distance, direction, and difference in elevation are covered with a degree of thoroughness consistent with the requirements of an elementary course. Descriptions of the instruments used are complete and are accompanied by clear cuts and drawings.

The examples of field notes that are given are well done, but the inclusion of still more of these would further strengthen the book. The weakness of the book is in the sections on calculations, especially in the calculation of area and the computation of level notes.

Problems are included at the end of each chapter in sufficient number that a choice is available for class work or outside assignment. The tables at the back of the book consist of: Natural Functions, Stadia Reductions, and Geometric and Trigonometric Relations.

This book is in a handy pocket size so that it is easy to carry. It is well written in clear simple language so that it should find wide use in short courses in surveying.

F. BROMILOW

Applied Mechanics. ALFRED P. POORMAN. McGraw-Hill Book Company. 354 pages.

In this latest edition of a well known text on engineering mechanics, the author has revised his sequence of subject matter in

order to provide better continuity. In the opinion of the reviewer, he has accomplished his purpose quite well. Those who have used the previous editions of this book will undoubtedly find the revised material in more logical sequence in the new edition.

All of the coplanar force systems have been treated prior to non-coplanar systems. The author feels that this is justified because they are more easily studied in this order and the student generally understands coplanar systems more readily than he does the non-coplanar.

Kinematics has been dealt with in one chapter instead of being interspersed through kinetics. The material on work, energy and power has also been consolidated in one chapter.

The data of all problems have been revised and additional problems introduced to take care of the expanding fields of engineering. As in previous editions answers have been given for the problems.

WM. T. HOOPER, JR.

INDEX, JOURNAL OF ENGINEERING EDUCATION, VOL. XXX (1939–40)

Ability of Students to Do the Work of the Upper Classes in the Engineering Colleges. W. H. Formals and Bradley Stoughton. 8, 668
Accredited Undergraduate Curricula. 5, 463
Accuracies of Different Types of Examination Questions. A. G. Conrad and J. W. Koopman. 10, 860
Activities of Graduates of School of Mines and Metallurgy, University of Minnesota, Study of. E. H. Comstock. 8, 708
Addresses:
Presidential: Engineering and Social Progress. K. T. Compton 1, 8
Welcome. H. P. Hammond. 1, 18
R. H. Hetzel. 1, 19
Administering State Board Examinations to Senior Engineers, Results of. C. T. Olmsted. 8, 690
Advantages of Naval Academy Instruction. E. W. Thomson. 8, 645
Aims and Scope of Engineering Curricula, Committee on:
Progress Report. 5, 475
Report. 7, 555
Artisans, Schools for. O. J. Ferguson. 10, 831
Basic Physics as a Part of Mathematics. Alan Hazeltine. 8, 699
Beginning of Engineering Education. T. T. Read. 4, 348
Berkeley Convention, Motor Touring to. L. C. Uren. 9, 754
Bibliography, Instructional Methods in Engineering, A. Wm. C. White. 9, 761
California in June, To. 5, 446
California Convention, The S.P.E.E. 7, 547
Chemical Engineering Curriculum, Service Courses in Undergraduate. L. T. Lawlor and W. N. Jones. 3, 270
Civil Engineering Page
1, 64; 2, 156; 3, 295; 4, 404; 5, 519; 7, 601; 8, 714; 9, 806; 10, 887
Comprehensive Examinations in Electrical Engineering at The Ohio State University. H. W. Bibber. 10, 848
Conference on Engineering Education, University of New Hampshire, Second Summer. 9, 753
Conflicting Views of the Definition of Engineering Economy. E. D. Ayres. 5, 485
Conservation of Mineral Resources. R. J. Lund. 3, 232
Content of Mechanical Engineering Curriculum. R. E. Flanders. 9, 803
Cooper Union, Department of Humanities at. W. S. Lynch. 9, 812
Coöperation Between Teachers of High School and of College English. T. J. Gates. 2, 168
Correlation of Laboratory Work in Strength of Materials with the Class Room Course. G. P. Boomsliter. 7, 583
Curricula:
Accredited Undergraduate. 5, 463
Report of Committee on Aims and Scope of Engineering 5, 475; 7, 555
Specialized Curricula in Mineral Dressing. P. C. Emrath. . . . 8, 704

CURRICULUM:
CONTENT OF MECHANICAL ENGINEERING. R. E. Flanders 9, 803
HUMANISTIC BAND IN THE ENGINEERING. W. E. Wickenden 3, 206
SERVICE COURSES IN THE UNDERGRADUATE CHEMICAL ENGINEERING. L. T. Lawlor and W. N. Jones 3, 270
DAY WITH EUCLID, A. Robins Fleming 9, 801
DESIGN AND CONSTRUCTION OF EXPERIMENTAL VACUUM TUBES IN ENGINEERING SCHOOL LABORATORIES. T. S. Gray 4, 372
DEVELOPMENT OF THE TEACHING OF MANAGEMENT TO ENGINEERS. C. W. Lytle 8, 677
DRAWING TIME, EFFECT OF THE TENDENCY TO REDUCE ENGINEERING. A. S. Levens 5, 496
ECONOMY, CONFLICTING VIEWS ON THE DEFINITION OF ENGINEERING. E. D. Ayres 5, 485
ECONOMY PAGE, ENGINEERING
1, 65; 2, 159; 3, 298; 4, 407; 5, 522; 7, 606; 8, 716; 9, 810; 10, 890
EFFECT OF THE TENDENCY TO REDUCE ENGINEERING DRAWING TIME. A. S. Levens 5, 496
ELECTRICAL ENGINEERING COURSES FOR MECHANICAL ENGINEERING STUDENTS. L. E. Beck 4, 382
ENGINEERING CURRICULA, REPORT OF COMMITTEE ON AIMS AND SCOPE OF 5, 475; 7, 555
ENGINEERING ECONOMY PAGE
1, 65; 2, 159; 3, 298; 4, 407; 5, 522; 7, 606; 8, 716; 9, 810; 10, 890
ENGINEERING EDUCATION:
BEGINNING OF. T. T. Read 4, 348
REPORT: PROGRESS IN, 1938–39 ..... 10, 832
TRENDS IN. D. C. Jackson 2, 138
SUMMARY OF PRESENT STATUS AND TRENDS IN. Chas. F. Scott 5, 540
ENGLISH:
CONCLUSIONS AND RECOMMENDATIONS. H. P. Hammond 8, 719
COÖPERATION BETWEEN TEACHERS OF HIGH SCHOOL AND OF COLLEGE ENGLISH. T. J. Gates 2, 168
DEPARTMENT OF HUMANITIES AT COOPER UNION. W. S. Lynch 9, 812
ENGINEERING-ENGLISH TEACHER'S TRAINING AND HIS PROPER TEACHING LOAD. L. A. Rose 5, 523
EXPERIMENT IN TEACHING LITERATURE IN ENGINEERING SCHOOLS. J. L. Vaughan 2, 177
ENGLISH MUST ADVERTISE—AND HOW! John Mills 1, 67
ORGANIZATION AND CONDITIONS. W. Otto Birk 4, 408
PROBLEM OF THE POORLY PREPARED STUDENT. A. M. Fountain 2, 166
TEACHERS OF ENGLISH IN ENGINEERING COLLEGES: SELECTION AND TRAINING. H. L. Creek 3, 300
THIRTY YEARS OF TEACHING ENGLISH TO ENGINEERS. W. O. Sypherd 2, 161
UNUSUAL PLANS AND METHODS IN ENGLISH. K. O. Thompson 7, 608
WHERE DO LANGUAGE HABITS RESIDE? Alfred Westfall 2, 171
ENGLISH NOTES
1, 67; 2, 161; 3, 300; 4, 408; 5, 523; 7, 608; 8, 719; 9, 812; 10, 893
ENGINEERING EDUCATION IN THE UNITED STATES, SUMMARY OF PRESENT STATUS AND TRENDS IN. Chas. F. Scott 5, 540
ENGINEERING ENROLLMENTS, 1939–40 ..... 5, 449
ENGINEERING GRADUATE STUDY. R. W. Sorensen 3, 203
ENGINEERING HISTORY AND THE CULTURAL BACKGROUND. R. H. Carey 8, 694
ENGINEERING AND SOCIAL PROGRESS. PRESIDENTIAL ADDRESS. K. T. Compton 1, 8

ENROLLMENTS, 1939–40, ENGINEERING 5, 449
EUCLID, A DAY WITH. Robins Fleming 9, 801
EVALUATING THE ABILITY OF STUDENTS TO DO THE WORK OF THE UPPER CLASSES IN THE ENGINEERING COLLEGES. W. H. Formals and Bradley Stoughton 8, 668
EXAMINATION QUESTIONS, ACCURACIES OF DIFFERENT TYPES OF. A. G. Conrad and J. W. Koopman 10, 860
EXAMINATIONS IN ELECTRICAL ENGINEERING AT THE OHIO STATE UNIVERSITY. H. W. Bibber 10, 848
EXPERIMENT IN TEACHING METHODS FOR THE COURSE IN MATERIALS LABORATORY. C. J. Posey 8, 686
EXPERIMENTS IN TEACHING LITERATURE IN ENGINEERING SCHOOLS. J. L. Vaughan 2, 177
FACTORS OTHER THAN INTELLECTUAL IN THE TRAINING OF THE ENGINEER. J. E. Raycroft 8, 660
FLOOD CONTROL. W. E. R. Covell 3, 244
FOREST CONSERVATION—A TASK IN ENGINEERING. Wilson Compton 3, 215
HISTORY AND THE CULTURAL BACKGROUND, ENGINEERING. R. H. Carey 8, 694
HUMANITIES AT COOPER UNION, DEPARTMENT OF. W. S. Lynch 9, 812
HUMANISTIC BAND IN THE ENGINEERING CURRICULUM. W. E. Wickenden 3, 206
IMPARTING KNOWLEDGE VS. DEVELOPING SKILLS IN TEACHING MECHANICS OF MATERIALS. W. L. De Baufre 7, 589
INTERMEDIATE PHYSICS IN THE ENGINEERING PHYSICS CURRICULUM. C. E. Bennett 8, 655
INSTRUCTIONAL METHODS IN ENGINEERING—A BIBLIOGRAPHY. Wm. C. White 9, 761
KNOWLEDGE AND WISDOM. D. S. Kimball 2, 148
LAMME AWARD. Stephen P. Timoshenko 1, 1
MANAGEMENT TO ENGINEERS, DEVELOPMENT OF THE TEACHING OF. C. W. Lytle 8, 677
MATERIALS LABORATORY, AN EXPERIMENT IN TEACHING METHODS FOR THE COURSE IN. C. J. Posey 8, 686
MATHEMATICS—A LANGUAGE. Evan Thomas 10, 842
MATHEMATICS AND THE ENGINEER. S. G. Hacker 4, 394
MATHEMATICS, BASIC PHYSICS AS A PART OF. Alan Hazeltine 8, 699
MECHANICAL ENGINEERING CURRICULUM. CONTENT OF. R. E. Flanders 9, 803
MECHANICAL ENGINEERING PAGE
1, 76; 2, 181; 3, 314; 4, 435; 5, 529; 7, 618; 8, 728; 9, 817; 10, 898
MEMBERSHIP 2, 99
MINERAL DRESSING, SPECIALIZED CURRICULA IN. P. C. Emrath 8, 704
MINNESOTA, STUDY OF ACTIVITIES OF GRADUATES OF SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF. E. H. Comstock 8, 708
MINUTES:
ANNUAL MEETING 1, 42
COUNCIL MEETINGS 1, 37
INSTITUTIONAL DELEGATES MEETING 2, 100
SUMMER SCHOOL FOR CHEMICAL ENGINEERING TEACHERS 3, 256
MOTOR TOURING TO BERKELEY CONVENTION. L. C. Uren 9, 754
NAVAL ACADEMY INSTRUCTION, ADVANTAGES OF. E. W. Thomson 8, 645
NEW HAMPSHIRE, SECOND SUMMER CONFERENCE ON ENGINEERING EDUCATION 9, 753
NECROLOGY:
GEORGE EARLE BEGGS 7, 621
LEWIS VAN CARPENTER 10, 913
ISAAC NEWTON CARTER 9, 820

Ralph Edwin Goodwin 7, 621
Clement Ross Jones 2, 191
Arthur Edwin Kennelly 1, 79
James Alfred Newton 9, 820
Henry H. Norris 10, 913
Henry E. Publow 8, 752
Joseph Walter Ramsay 1, 79
Walter S. Rugg 9, 822
Lester L. Schuldt 5, 517
Stanley Sylvester Seyfert 7, 621
George Hugh Shepard 3, 318
Embert Hiram Sprague 8, 735
Frederick Newton Willson 7, 622
Oregon State College, Invitation from 9, 753
Organization and Conditions. W. Otto Birk 4, 408
Our Convention. O. J. Ferguson 5, 445
Photoelasticity Demonstrations as Teaching Aids in Strength of Materials. M. M. Frocht 7, 567
Physics in the Engineering Physics Curriculum, Intermediate. C. E. Bennett 8, 655
Physics as a Part of Mathematics, Basic. Alan Hazeltine 8, 699
Popularizing Research. Watson Davis 5, 491
Practice and Teaching of Electrical Design. T. C. Lloyd 4, 354
Pre-Engineering College Education. D. B. Steinman 4, 337
Discussion of. G. C. Ernst 5, 476
Presidential Address: Engineering and Social Progress. K. T. Compton 1, 8
Problem of the Poorly Prepared Student. A. M. Fountain 2, 166
Program of the 47th Annual Meeting 1, 46
Progress, Engineering and Social. K. T. Compton 1, 8
Progress in Engineering Education, 1938–39, Report 10, 832
Research, Popularizing. Watson Davis 5, 491
Response to Address of Welcome. K. T. Compton 1, 18
Results of Administering State Board Examinations to Senior Engineers. C. T. Olmsted 8, 690
Reports: Aims and Scope of Engineering Curricula 5, 475; 7, 555
Chemical Engineering 2, 106
Civil Engineering 5, 478
Comprehensive Examinations 2, 111
Coöperative Engineering Education 2, 111
Electrical Engineering 2, 112
Engineering Economy 2, 114
Engineering Research 2, 115
English 2, 117
Industrial Engineering 2, 120
Instructional Methods 2, 123
Mathematics 2, 127
Mechanical Engineering 2, 131
Mechanics 2, 128
Mineral Technology 2, 133
Orientation of Freshmen 4, 392
Physics 2, 136
Progress in Engineering Education, 1938–39 ..... 10, 832
Secretary 1, 61
Treasurer 1, 59

Safe Practices in College Laboratories. M. S. Coover 9, 789
Schools for Artisans. O. J. Ferguson 10, 831
Second Summer Conference on Engineering Education, University of New Hampshire 9, 753
Selection and Training, Teachers of English in Engineering Colleges. H. L. Creek 3, 300
Selection of Engineering Students—Discussion. R. L. Sackett 7, 595
Service Courses in the Undergraduate Chemical Engineering Curriculum. L. T. Lawlor and W. N. Jones 3, 270
Should Moment Distribution be Taught to Undergraduates? S. H. Fillion 2, 156
Social Progress, Engineering and. K. T. Compton 1, 8
Social Responsibility of the Engineer. R. E. Doherty 1, 27
Specialized Curricula in Mineral Dressing. P. C. Emrath 8, 704
Stanford University. S. B. Morris 8, 637
State Board Examinations to Senior Engineers, Results of Administering. C. T. Olmsted 8, 690
Status and Trends of Engineering Education in the United States, Summary of Present. Chas. F. Scott 5, 540
Strength of Materials, Photoelasticity Demonstrations as Teaching Aids in. M. M. Frocht 7, 567
Strength of Materials with the Class Room Course, Correlation of Laboratory Work in. G. P. Boomsliter 7, 583
Study of Activities of Graduates of School of Mines and Metallurgy, University of Minnesota. E. H. Comstock 8, 708
Summary of "Present Status and Trends in Engineering Education in the United States." Chas. F. Scott 5, 540
Teacher Qualifications and Development. A. B. Newman 3, 281
Teachers of English in Engineering Colleges: Selection and Training. H. L. Creek 3, 300
Teaching Lubrication. L. J. Bradford 10, 870
Technical Institutes? Whither. P. R. Kolbe 8, 643
Tentative Itinerary to 1940 Meeting 5, 448
There Is so Much to Do. O. J. Ferguson 1, 5
Thirty Years of Teaching English to Engineers. W. O. Sypherd .. 2, 161
Training Engineers to Handle Men. M. H. Clark 10, 855
Training, Teachers of English in Engineering Colleges: Selection and. H. L. Creek 3, 300
Trends in Engineering Education. D. C. Jackson 2, 138
Trends of Engineering Education in the United States, Summary of Present Status and. Chas. F. Scott 5, 540
T-Square Page
1, 77; 2, 183; 3, 316; 4, 437; 5, 532; 7, 620; 8, 730; 9, 818; 10, 902
Understanding Plus. D. B. Prentice 4, 335
Unusual Plans and Methods in English. K. O. Thompson 7, 608
Use, Care and Maintenance of Laboratory Instruments. H. N. Hayward 5, 506
Vacuum Tubes in Engineering School Laboratories, Design and Construction of Experimental. T. S. Gray 4, 372
Where Do Language Habits Reside? Alfred Westfall 2, 171
Whither Technical Institutes? P. R. Kolbe 8, 643
Wisdom, Knowledge and. D. S. Kimball 2, 148

AUTHORS' INDEX, VOL. XXX (1939–40)

AYRES, E. D. Conflicting Views of the Definition of Engineering Economy 5, 485
BECK, L. E. Electrical Engineering Courses for Mechanical Engineering Students ... 4, 382
BENNETT, C. E. Intermediate Physics in the Engineering Physics Curriculum ... 8, 655
BIBBER, H. W. Comprehensive Examinations in Electrical Engineering at The Ohio State University ... 10, 848
BIRK, W. OTTO. Organization and Conditions ... 4, 408
BOOMSLITER, G. P. Correlation of Laboratory Work in Strength of Materials with the Class Room Courses ... 7, 583
BRADFORD, L. J. Teaching Lubrication ... 10, 870
CAREY, R. H. History and Cultural Background ... 8, 694
CLARK, M. H. Training Engineers to Handle Men ... 10, 855
COMPTON, K. T. Engineering and Social Progress ... 1, 8
COMPTON, WILSON. Forest Conservation ... 3, 215
COMSTOCK, E. H. Activities of Graduates of School of Mines and Metallurgy, University of Minnesota ... 8, 708
CONRAD, A. G., AND J. W. KOOPMAN. Accuracies of Different Types of Examination Questions ... 10, 860
COOVER, M. S. Safe Practice in College Laboratories ... 9, 789
COVELL, W. E. R. Flood Control ... 3, 244
CREEK, H. L. Teachers of English in Engineering Colleges: Selection and Training ... 3, 300
DAVIS, WATSON. Popularizing Research ... 5, 491
DEBAUFRE, W. L. Imparting Knowledge vs. Developing Skills in Teaching Mechanics of Materials ... 7, 589
DOHERTY, R. E. Social Responsibility of the Engineer ... 1, 27
EMRATH, P. C. Specialized Curricula in Mineral Dressing ... 8, 704
ERNST, G. C. Discussion: Pre-Engineering College Education ... 5, 476
FERGUSON, O. J. There Is so Much to Do ... 1, 5
Our Convention ... 5, 445
Schools for Artisans ... 10, 831
FILLION, S. H. Should Moment Distribution be Taught to Undergraduates ... 2, 156
FLANDERS, R. E. Content of Mechanical Engineering Curriculum ... 9, 803
FLEMING, ROBINS. A Day with Euclid ... 9, 801
FORMALS, W. H., AND BRADLEY STOUGHTON. Ability of Students to do Work of the Upper Classes in the Engineering College ... 8, 668
FOUNTAIN, A. M. Problem of the Poorly Prepared Student ... 2, 166
FROCHT, M. M. Photoelasticity Demonstrations as Teaching Aids in Strength of Materials ... 7, 567
GATES, T. J. Coöperation Between Teachers of High School and of College English ... 2, 168
GRAY, T. S. Design and Construction of Experimental Vacuum Tubes in Engineering School Laboratories ... 4, 372
HACKER, S. G. Mathematics and the Engineer ... 4, 394
HAMMOND, H. P. Address of Welcome ... 1, 18
Conclusions and Recommendations on Report on English ... 8, 719
HAYWARD, H. N. Use, Care and Maintenance of Laboratory Instruments 5, 506

HAZELTINE, ALAN. Basic Physics as a Part of Mathematics 8, 699
HETZEL, R. H. Address 1, 19
JACKSON, D. C. Trends in Engineering Education 2, 138
JONES, W. N., AND L. T. LAWLOR. Service Courses in Undergraduate Chemical Engineering Curriculum 3, 270
KIMBALL, D. S. Knowledge and Wisdom 2, 148
KOLBE, P. R. Whither Technical Institutes? 8, 643
KOOPMAN, J. W., AND A. G. CONRAD. Accuracies of Different Types of Examination Questions 10, 860
LAWLOR, L. T., AND W. N. JONES. Service Courses in Undergraduate Chemical Engineering Curriculum 3, 270
LEVENS, A. S. Effect of the Tendency to Reduce Drawing Time 5, 496
LLOYD, T. C. Practice and Teaching of Electrical Design 4, 354
LUND, R. J. Conservation of Mineral Resources 3, 232
LYNCH, W. S. Department of Humanities at Cooper Union 9, 812
LYTLE, C. W. Development of the Teaching of Management to Engineers 8, 677
MILLS, JOHN. English Must Advertise—And How! 1, 67
MORRIS, S. B. Stanford University 8, 637
NEWMAN, A. B. Teacher Qualifications and Development 3, 281
OLMSTED, C. T. Result of Administering State Board Examinations to Senior Engineers 8, 690
POSEY, C. J. Experiments in Teaching Methods for the Course in Materials Laboratory 8, 686
PRENTICE, D. B. Understanding Plus 4, 335
RAYCROFT, J. E. Factors Other than Intellectual in the Training of Engineers 8, 660
READ, T. T. Beginning of Engineering Education 4. 348
ROSE, L. A. Engineering English Teacher's Training and his Proper Teaching Load 5, 523
SACKETT, R. L. Selection of Engineering Students—A Discussion 7, 595
SCOTT, CHAS. F. Summary of Present Status and Trends in Engineering Education in the United States 5, 540
SORENSEN, R. W. Engineering Graduate Study 3, 203
STEINMAN, D. B. Pre-Engineering College Education 4, 337
STOUGHTON, BRADLEY, AND W. H. FORMALS. Ability of Students to Do Work of the Upper Classes in the Engineering College 8, 668
SYPHERD, W. O. Thirty Years of Teaching English to Engineers 2, 161
THOMAS, EVAN. Mathematics—A Language 10, 842
THOMPSON, K. O. Unusual Plans and Methods in English 7, 608
THOMSON, E. W. Advantages of Naval Academy Instruction in the United States 8, 645
UREN, L. C. Motor Touring to Berkeley Convention 9, 754
VAUGHAN, J. L. Experiments in Teaching Literature in Engineering Schools 2, 177
WESTFALL, ALFRED. Where Do Language Habits Reside? 2, 171
WHITE, WM. C. Instructional Methods in Engineering—A Bibliography 9, 761
WICKENDEN, W. E. Humanistic Band in the Engineering Curriculum .. 3, 206

INSTRUCTION IN ENGLISH IN ENGINEERING COLLEGES

A Report Prepared Under the Direction of the Committee on English of the Society for the Promotion of Engineering Education

Office of the Secretary of the Society
F. L. Bishop
University of Pittsburgh
Pittsburgh, Pa.

1940

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CONTENTS

PAGE

PREFACE

Edward C. Elliott 5

PART I

CONCLUSIONS AND RECOMMENDATIONS

H. P. Hammond 7

PART II

MATERIALS AND COMMENTS

INTRODUCTORY NOTE. Karl T. Compton 15

CHAPTER I. *The Function of the Department of English in the School of Engineering.* H. P. Hammond 15

CHAPTER II. *English Composition in Colleges of Engineering.* George Summey, Jr. 19

CHAPTER III. *Literature in the Engineering College.* J. L. Vaughan 32

CHAPTER IV. *Speech Training in Schools of Engineering.* Donald Hayworth 42

CHAPTER V. *Teachers of English in Engineering Colleges: Selection and Training.* H. L. Creek 52

CHAPTER VI. *Organization and Conditions.* W. Otto Birk. 66

CHAPTER VII. *Unusual Plans and Methods in English.* Karl O. Thompson 93

PREFACE

EDWARD C. ELLIOTT, President, Purdue University

At the annual convention of the Society for the Promotion of Engineering Education held in June, 1936, the Conference on English proposed to the Council of the Society that a study of instruction in English in engineering colleges be undertaken. The reasons for the recommendation were the reputed failure of instruction in English in the technical institutions to achieve reasonable results and the belief that previous studies of English instruction had not considered adequately the special problems of technical and other professional students. The Council of the Society approved the recommendation, and the officers took steps to obtain funds with which to conduct the investigation. Early in 1937 the Carnegie Foundation for the Advancement of Learning generously made a grant of $2500.

With this encouragement the Committee on English began its work. First, it collected facts and opinions concerning actual conditions of instruction, together with suggestions for betterment. Letters were received from hundreds of practicing engineers, employers of engineering students, administrators in engineering colleges, professors of engineering, heads of departments of English, other teachers of English, and even undergraduate engineering students. This material was carefully sifted and studied by the authors of the various chapters in this report. These chapters have appeared serially in the *Journal of Engineering Education* during 1939 and 1940 and are now brought together in a small volume for the convenience of all who may be interested.

The Committee was aware of other studies of instruction in English. The most important of these is *The Teaching of English in England* (1921). It shows clearly that the complaints about the results of English instruction in England are almost identical with those in this country and makes sensible proposals for improvement. Conditions in England are not the same as those in the United States, however, and this study did not make similar studies in the United States superfluous. Another well-known study is *The Teaching of College English* (1934), prepared under the auspices of the National Council of Teachers of English. It is interesting and valuable, but is conservative in its attitude and has only a few pages regarding English in the professional colleges.

There seemed clearly to be a place for the study undertaken by the Society for the Promotion of Engineering Education.

The preparation of this Report would not have been possible without the devoted and sustained attention of the members of the Committee. Each has contributed generously of his time, energy, and thought. In particular, much credit is due Professor H. L. Creek, who has skilfully and industriously performed most of the duties belonging to the chairman. The generous hospitality of Chancellor John G. Bowman of the University of Pittsburgh has added much to the convenience and profit of the meetings of the Committee. As usual the Secretary of the Society, Dr. F. L. Bishop, has been invaluable in making arrangements for the work of the Committee. And Dean H. P. Hammond of the Pennsylvania State College, during whose term as President of the Society the investigation was undertaken, has given aid the importance of which only the Committee members can appreciate.

PART I

CONCLUSIONS AND RECOMMENDATIONS

By H. P. HAMMOND

Dean, School of Engineering, Pennsylvania State College

The substance of this report is embodied in the seven chapters that follow, dealing respectively with the function of the department of English in the school of engineering; the teaching of composition, literature, and speech; the selection and training of teachers; the organization of the English department and conditions surrounding its work; and variants on methods commonly employed in English instruction. Each of these chapters comprises summaries of fact and opinion. Part I summarizes these chapters and presents the recommendations of the committee in charge of the study.

It is scarcely necessary to say that the committee disavows any attempt at finality in this report. Not only have the problems of the teaching of English engaged the attention of many of the leaders in engineering education for a long period, but every aspect of the subject will continue to require the best study that can be brought to bear upon it. It is our hope, rather, to contribute to this process of evaluation and remedy, and to present the constructive conclusions that may be drawn from the opinions of those who have been consulted.

Summary of Opinions

Of fundamental importance is the conviction, now held almost universally, that adequate training in English is vital in the collegiate education of the engineer if he is to take his proper place in professional and public life. This was not always so, but now we may repeat—"The battle of the place of English in engineering education has been fought and won." We may therefore pass on to the problems of making literate engineers of the students who enter engineering colleges with all the defects of education and background that the secondary schools have been unable to remedy among the numerous and heterogeneous student populations with which they have to deal.

This is indeed a monumental task, and it would not be surprising if results fell short of expectation. With all due allowance

for the inherent difficulties, however, a great many thoughtful observers believe that better results could be and should be achieved. Criticisms of instruction in English have even greater force when they come, as many of them do, from graduates who have become conscious of their deficiencies. The committee believes that these criticisms are essentially valid and that schools of engineering, by and large, are not producing among their graduates the level of literacy properly to be expected of them.

It is also agreed by a majority of those who expressed themselves that all of the three common forms of instruction should be provided: composition, literature, and speech. Although it is commonly believed that the level of preparation of entering students is such as to make drill in the elements of grammar and punctuation and the building up of vocabularies essential, the objectives of English courses should not be confined to this purpose. A major aim is the development of ability to arrange a process of thought in systematic and logical form and to express it clearly and concisely.

It is noted, also, that there is a good deal of insistence on the part of graduates, and particularly of older graduates, that their greatest lack in ability to express themselves properly is in oral rather than written English.

The committee's inquiries brought forth fewer spontaneous comments than might have been anticipated as to the quantitative provisions for English in the curriculum. Although the significance of this might be misinterpreted, it seems reasonably clear that it is the quality of instruction rather than its quantity that is most seriously questioned. It should be noted in this connection, however, that provisions for English are very uneven among engineering colleges. In a considerable number of them these provisions should be substantially increased in order to provide adequately for the three types of instruction just mentioned.

A number of correspondents raised the question of the disposition of the time allotment for English. There is a growing belief that some portion at least of this time should be reserved for the later years of the curriculum, when the greater maturity of the students as well as the greater degree of spontaneous interest that has been observed among upper classmen will yield correspondingly more effective and more lasting results.

It is also evident that courses in English are too often limited to a mere drill course in composition, to the neglect of the vital opportunities that may be realized from the study of the masterpieces of English literature. It is doubtless true that our writing habits are formed in considerable measure by what we read, just as we learn to speak from what we hear.

Many voice the opinion that it is only through the active sup-

port and coöperation of their engineer colleagues that the efforts of teachers of English may be made effective. With this view the committee is in full accord. As a corollary, it is evident that there exists a problem of faculty as well as of student improvement in English usage. Until the great body of engineering teachers are themselves proficient in English it is hopeless to expect students to continue to observe good standards after the English department has taught them all it can.

Conditions Favorable to Good Work in English

The Teacher

Good teachers are the *sine qua non* of good teaching. While everyone will agree with this axiomatic statement, its full significance in relation to the teaching of English to engineering students may not be so clearly evident. For one thing, the problem we are here considering is probably the most difficult of all those encountered in the school of engineering. It is not merely a matter of starting from zero to build up a proficiency that is difficult at best to establish, but in many cases of starting from below zero because it is necessary to eradicate deeply ingrained faults, inculcated in home and community backgrounds. Moreover, it is necessary to deal with students whose interests are pretty firmly fixed on definite vocational aims to which, as they conceive them, the relationship of English is not evident. Furthermore, the teacher of English is thrown on his own resources to a greater degree than are most of his colleagues in science or engineering. By the nature of his work, the textbook—that safe support of mediocre teaching—is but an incidental aid to his work rather than its essential basis. Because of the relatively high degree of personal relationship that should always obtain, and often does, he must possess unusually high qualities of leadership as well as of ability to interest and to inspire his students. In a word (an old-fashioned and often misunderstood and abused one), the teaching of English is to a great extent a matter of pedagogy; and great pedagogues are rare in the land!

The quality of a teaching staff depends directly, of course, upon the care and skill with which it is chosen. We would say, therefore, and with some emphasis, that the college administrator who complains of the work of his English staff might, in many cases, look to himself in the first instance as the one responsible for its selection and for the conditions under which it works. On the other hand in no other field of instruction is it more difficult to choose young teachers who may be expected to develop the special qualities that the nature of their work requires.

Many of the criteria of selection that serve usefully in other fields are not equally helpful in selecting teachers of English. The Ph.D. degree, for example, which is so often insisted upon in liberal arts faculties, by no means insures that its holder is competent to teach composition to sections of engineers. Success in that work depends on ability to judge accurately and to deal astutely with students whose major interests lie elsewhere fully as much as it depends on scholarly attainment in advanced phases of English literature, important as that may be in other situations. Difficulties of attracting good men are due in large measure, also, to the fact that the position offered is often limited to the teaching of elementary courses in composition and provides little or no opportunity for the satisfaction of those professional ambitions that are likely to have been developed by advanced specialized study in the graduate school.

This limitation to the teaching of English in engineering schools is, indeed, a matter of major concern, for unless means can be found to accord the teacher recognition commensurate with the importance of his professional work, strong staffs cannot be held together even if they can be once assembled. To this we would add that compensation of teachers of English should be on the same scale as that of teachers of engineering of comparable faculty rank, and there should be about the same distribution by ranks as obtains in other divisions of the faculty. In the long run, a staff is likely to be no better, in comparison with other staffs, than its rate of compensation is in comparison with theirs. It is unfortunate that in many instances the pressure to secure competent men for specialized engineering teaching has obscured the equally vital necessity of securing good men for English. In each English staff there should be at least one really first-class man whose leadership will raise the level of the entire group, whose views will be respected by his engineering colleagues, and whose qualifications will tend to set the standard when new men are chosen. Such a man should be compensated at the maximum rate which the school affords.

According to the evidence and opinions supplied by correspondents, the particular type of educational program that teachers of English have followed in preparing for their careers is not so important as is sometimes asserted. There are too many instances of strong staffs comprising individuals having various educational backgrounds, to support the idea that teachers of English to engineers must have received any one kind of preparatory training. This applies in particular to the contention that such teachers should be engineering graduates. True, they should have acquired an understanding of and a sympathetic attitude toward engineering students and they should have such a general conception and ap-

preciation of the world of science and technology as any broadly educated man should have. What is required is good teachers; everything else is secondary. If those who teach engineers are really good teachers, they will soon develop the points of view and the attitudes that will make for success with their particular student groups.

There is, however, one very important point concerning the preparation of teachers of English that must be raised: the neglect that prevails in graduate schools of systematic preparation of their students for the teaching of composition. Many who pursue advanced courses in English are destined to make the teaching of composition an important part of their future careers, and some of them will make it their life work. Yet neither graduate schools of liberal arts nor graduate schools of education make preparation for such work an element of any significance in their programs. This is a lack that deserves widespread attention.

Finally, it is essential that teachers of English should not be required to carry unreasonable teaching schedules, either in number of class hours or in number of students. Teaching loads should be such that ample provision may be made outside of class periods for conferences with individual students. We are convinced that there should be a reversal in the allotment of time for class work and for conference work respectively, for the latter is by far the more effective teaching procedure. It is not only more effective in training students in the organization and presentation of thoughts; it is also very much more effective as a means of correcting faults in writing and speaking. At present the conference is usually regarded as a subordinate adjunct of class recitations. We believe that the emphasis should be reversed.

Objectives of Instruction in English

To the foregoing observations concerning the teacher as a factor in providing conditions favorable to good instruction in English, we would add the necessity of setting clear objectives of the teaching program. These objectives should be formulated in terms of the knowledge and skills that the student is expected to achieve and the motivation he is to receive to further independent reading and study. In many instances, we feel safe in saying, the objectives of a program of instruction in English have been conceived of merely in terms of conventional courses of study to be taken and of the number of credits to be earned. They have not been arrived at as a result of a thoroughgoing analysis of the basic factors involved in the institution, its environment, its clientele, and the scope and requirements of engineering practice. Such an analysis is needed, not only in setting curriculum allowances—which should, of course,

be adequate—but also in setting the specific objectives of each course and of the program as a whole in its relationship to the rest of the curriculum. We would emphasize that work in English should be planned as a *program* leading to specific objectives and adapted to the needs, interests, and abilities of students. It should be formulated just as the major sequences of courses in engineering are planned, rather than as a mere group of courses of traditional content arranged in a series based upon an assumption—largely unwarranted—of specified "prerequisites."

Coöperation of the Engineering Faculty

For good results in English, it cannot be said too often that the active support and coöperation of the engineering staffs are indispensable. This is something more than a general endorsement of English by engineering teachers; it requires their insistence at all times that their students shall continue without backsliding to write and speak according to the standards which the English staffs have established. The price for keeping students up to a given level of achievement in any field of study, and especially in English, where former habits are so likely to crop out at any time, is eternal vigilance. The English staff which deals with the student for a relatively small fraction of the time cannot do this; it is a duty that the entire engineering staff must assume. It is not enough to examine written work for grammar, spelling, and punctuation, although this is certainly important; the student should be shown how he might have organized his thoughts more logically and expressed them more clearly and concisely. In other words, the teacher of engineering should continue to teach the student the fundamental processes of thought and expression. These are vital to success in any engineering course, and are just as much a part of it as they are of courses in English. The teacher of engineering cannot escape this responsibility; it is as much a part of his work as it is to see that the student learns to think logically on scientific matters by deriving formulas; both are forms of training in processes of clear, logical thinking and of expressing the results of such thinking, one being in words and the other in symbols. Sloppiness in either of these is indicative of sloppiness in the other; and tolerating sloppiness in either is indicative of low teaching standards.

Finally, in order to establish and maintain good work in English the effective support of the college administration is necessary at all times. In the situation surrounding instruction in English nothing is more necessary to the maintenance of morale than is the knowledge that the administrative officers and department heads are giving the English staff their support and coöperation, that they are ready to consult with their colleagues in English, and that

they consider English a thoroughly integrated part of the program of engineering education. Administrative support means also willingness to provide the necessary accessories of English instruction in the same measure that laboratories are provided as accessories in engineering.

Development of Teachers

In addition to the maintenance of favorable surrounding circumstances, we believe that the cause of English instruction in our schools of engineering will be promoted by experimentation, just as engineering education at large has benefited by the trial of variants on conventional methods. An inquiry as to such experiments, made as a part of this committee's work, has disclosed a number of examples of the adoption of departures from conventional procedures. A chapter of this report describes several of these. Most of them are concerned with types of courses or unique methods of instruction, in other words with the work of the teacher; none deals specifically with the other phase of the problem—the development of the teacher himself.

Herein, we feel, lies a great need and opportunity. We believe that the time is ripe for the inauguration of specific means for developing teachers of English both on an institutional and on a regional or national basis. To that end we advocate the trial establishment in a few representative institutions of definite plans, under carefully controlled conditions, for the study of teaching procedures by groups of younger teachers under the guidance of skilled and inspiring older members of the staff. Study should be devoted to course content and teaching methods with a view to the development of improved techniques. Arrangements might be made for these younger teachers to observe and study the methods of their more experienced colleagues; and their own methods might, in turn, be observed and criticized in an organized program of practice teaching. When possible, this procedure might be accompanied by concurrent and related study in a neighboring university having versatile and inspiring teachers of English whose courses could be pursued and whose methods could be observed. Such a plan, requiring a lightening of teaching schedules during the period of the experiment, would entail an increased budget allotment for English.

If this plan could be given a trial under the general supervision of a central agency, such as a committee of the Society for the Promotion of Engineering Education, it could be coördinated and observed systematically and the results made known from time to time as the work progressed.

A second possibility is the selection of some one institution, or possibly even two or three, which would establish, for a trial period and with financial aid, centers for the training and development of a carefully selected group of younger teachers from other institutions under the leadership and the instruction of a member or members of the staff of the host institution. Fortunately there are institutions which have the prime requisites of this plan—a single man, or a staff, with the capacity and the qualities of leadership needed for its success. This plan, also, might be undertaken under some form of general sponsorship so that it could be looked upon as the undertaking of the fraternity of engineering education at large, with the advantages of general interest which would thus accrue to it.

Conclusion

In concluding this report our committee would affirm as a basic conception of work in English, whether for engineers or for other groups, that the portion of the experience of the individual in his effort to achieve requisite ability in the art of expression which is encompassed by the period of study in college, is but one part—a very important one, it is true—of his total program of development. And it should be so considered and evaluated. The college portion of this program begins at a level determined by home and community backgrounds and by previous schooling. Starting from this level it leads the student to some more or less advanced stage of his development. If it is properly conceived and executed, it relates that stage to his immediate future and to his more remote future as well, to the vocational field he will enter, and to the position in society at large that he will achieve, neglecting no one of these aims at the expense of the others. Of basic importance, his period of college training in English should motivate him to continued study and development, not only in the arts of written and oral expression but also in other fields of cultural interest that are related to the study and use of the mother tongue. He should be given such a view of all that is preserved in the writings of our greatest creative minds that he will have the incentive to explore them for himself and thus to enrich his entire life. Of all the members of the faculty of the engineering school, it is the teacher of English who has the unique opportunity thus to direct the student toward this phase of his future development. It is also, without doubt, his greatest responsibility.

PART II

MATERIALS AND COMMENTS

INTRODUCTORY NOTE

By KARL T. COMPTON *

President of the Massachusetts Institute of Technology

The teaching of English in engineering colleges presents educational problems of exceptional interest. On the one hand, engineering students are primarily interested in quite different subjects and are inclined to view the study of English as a "chore" which interrupts their more important activities. On the other hand, they feel its importance so acutely, after they have had experience in their careers, that they almost universally wish they had obtained better training in the arts of written and oral expression while in college. Also there is no question but that engineering educators are becoming conscious of a need for more attention to the development of cultural interests and social attitudes in their students—a program in which the department of English has a strategic opportunity.

Perhaps it is the stimulus afforded by such problems which has, in many engineering colleges, led to exceptional energy, originality and skill in English instruction. Yet there is need for improvement all along the line, from the most to the least successful of our English departments, and there is decided interest in a critical study of objectives, methods and results of instruction.

I

THE FUNCTION OF THE DEPARTMENT OF ENGLISH IN THE SCHOOL OF ENGINEERING

By H. P. HAMMOND

Underlying any discussion of the place and function of the department of English in the school of engineering there should be recognized and accepted one basic idea: the responsibility for the

* Dr. Compton was the President of the Society for the Promotion of Engineering Education when the publication of the report was begun. This "Introductory Note" is part of President Compton's "Preface."

development in students of the habit of correct expression does not rest on the department of English alone. Every department and every teacher of the school of engineering should be concerned all the time. What is to be developed is the *habit* of correct expression; but the formation of the habit is not to be accomplished only by regular formal instruction, however excellent. It requires constant effort and perpetual vigilance. From many students deeply ingrained habits of speech and modes of thought that have been forming since early childhood must be eradicated. Even for students relatively susceptible to learning by absorption from examples this takes a great deal of time, and they must be continuously exposed to the right sort of examples. Conscious and persistent effort is needed.

All educators must assume their shares of this responsibility. Nothing is to be gained by censuring the high schools for the faults in English of students entering college. For that matter the college may not do its job as well as the high school. Habits of writing and of speech, it has been said, are formed before the age of thirteen; and it would seem clear that wrong habits acquired in early youth cannot be eradicated in high school alone. The college must do its part. Moreover, the problem concerns every teacher of an engineering subject just as directly as it does the teachers of English.

As for the department of English itself, in engineering education at least it has four major functions:

First, it is responsible for training students to write and to speak correctly and with facility. To that end there must usually be included in the college courses drill in grammar and in punctuation; and the training must include spoken as well as written English.

The second function arises from the nature of the engineering curriculum, in which there usually devolves upon the department of English the fostering of the liberal or cultural phases of a student's education. For that, in the opinion of many, the chief medium is the reading and study of literature, which therefore should form a part of every college curriculum. This applies to the engineering school fully as much as to any other division of higher education, although from the limitations of their professional program engineers cannot undertake as extensive work in literature as can students who have specialized interests in it. The study of literature in the engineering curriculum should be introductory. It should be a soundly conceived introduction to the systematic reading of good literature and thereby foster in the student a desire for such reading with results that may continue throughout his life. By the examples which it presents it should

aid the development of his ability to read and to speak correctly. In this development the importance of work in literature is not realized perhaps as widely as it might be. Most of us, if we trace the sources of our methods and style in writing, will find them probably in what we have read, just as we should find our habits of speech formed largely by what we have heard.

The third function of the department of English is to act as a "service" department for the other departments of the school of engineering; upon request, to assist faculty and students alike in the constructive criticism of their written work; to prevent lapse into former bad habits of students who have passed their required English courses; and to aid those who wish assistance in the preparation of speeches. This function implies close and well planned coördination with other departments. English departments, however, are usually more than willing to coöperate; and examples are to be found of very effective coördination.

Equally important, although more specialized, is the fourth function: that of rendering service by diagnosing the particular difficulties of students and by prescribing remedies. Speech defects and faulty methods of reading require such treatment; and service is now being rendered in a large number of cases to students whose scholastic difficulties are attributable chiefly to their inability to read textual matter correctly.

To these positive statements of function there may be added a negative: a disclaimer that it is the function of the department of English to train students in the writing of technical reports. That, it seems clearly, is the duty of each engineering department. The organization and forms of expression in such reports, as well as their technical subject matter, are its responsibility. They are part of the obligation which engineering teachers should assume of developing in their students powers of expression. This statement does not imply, of course, that excellent results may not often attend the coöperation of the department of English with the departments of engineering in the criticism of these reports as to details of usage. In many institutions, moreover, departments of English offer courses in technical writing and business correspondence that supplement effectively the training in the preparation of reports and other specialized writing done in connection with courses in engineering.

The statements which have just been made are all derived from the present survey of the teaching of English in schools of engineering. Opinions as to the various aspects of such teaching were collected from several groups—college presidents, deans, professors, and graduates. They were in substantial agreement as to the first three of the functions enumerated above. They did not, of course,

agree on all points, and their emphasis varied; but there was nevertheless a considerable measure of agreement on all the previous statements.

The survey also included a question as to measures that might be taken to improve the quality of instruction in English and to obtain better results. Some of the replies described very interesting and original methods. It is hoped that a number of these may be given trial to determine the extent of their practicability; but their description is not a part of the present paper.

In the replies there occurred frequently one basic idea which cannot be emphasized too often: the results of instruction in English depend almost completely on the quality of the staff of the department. That quality, in the long run, depends upon the recognition, compensation, and opportunity for satisfaction of professional ambitions that are offered. Recognition and compensation are two requirements that it is possible to meet. At least it should be possible, for if there is any department of an engineering school in which the best men obtainable are required it is that of English; and its best men should be accorded the same academic rank and title and the same compensation as similar members of other departments. Unfortunately this is not always the case. Unfortunately also, in institutions with a university form of organization the English department does not always assign its abler teachers to instruct engineering students. The third requirement, that of providing an opportunity for the satisfaction of professional aims and ambitions, is not so easily met. But it can be, as is evidenced by some institutions in the quality of their English staffs and in their results.

The answers to the Committee's questionnaire were unanimous in placing English among the basic essentials of the engineering curriculum. The recognition, therefore, of the position of English in engineering education is no longer a problem. Engineers in practice and teachers of engineering alike agree that the ability to write and speak properly is a prime requisite for an engineer.

II

ENGLISH COMPOSITION IN COLLEGES OF ENGINEERING

By GEORGE SUMMEY, Jr.

Head of the Department of English in the Agricultural and Mechanical College of Texas

In the preparation of this chapter the writer has examined a mass of material received by the Committee on English from departments of English, presidents and deans, instructors, engineering graduates, and employers, in answer to the committee's questions concerning content and methods of instruction, successful or unsuccessful experiments, attempts to stimulate interest in English on the part of engineering students, results desired, and results achieved.

As the committee has not conducted a factual survey, the material cannot be reduced to statistical statement, because the questions gave much room for varieties of opinions, emphasis, or factual statement. For these reasons the writer of this chapter cannot hope to count authorities for and against every proposition that must be mentioned, or couple a warranted solution with every problem the survey has raised. Perhaps the best one can hope to do is to set forth some of the problems we have to face.

The Ruling Purpose in Freshman English Composition

The well known report by Professor Oscar J. Campbell entitled *The Teaching of English Composition* (1934) outlined as follows two rival theories of the function of freshman English composition:

(*a*) *Mechanical skill*—"competence in 'spelling, punctuation, paragraphing, logical and clear transition, and accuracy and variety in sentence structure'—*the very qualities . . . which should be expected of entering freshmen.*" (Italics not in the original.)

(*b*) *Training in thinking.* Those who hold this theory emphasize the necessity of emphasizing material rather than words, of challenging the freshman's mind, of inducing the student to use living material and to make his thoughts articulate. "A student's freshman year is one of the times

> in his life when his new intellectual acquisitions are the richest. They will remain confused and of little significance unless he is given just that opportunity to articulate and express them offered by a course in systematic writing."

According to the first theory, matters of form are vital; thought and expression may wait until the semiliterate freshman has had enough drill, brutal drill if necessary, to be made over into a literate college student. Those who take this view must logically admit that a freshman who turns out to be well prepared should be excused from the course and allowed to give his time to something better. In actual fact it appears that few institutions exempt superior freshmen from the usual freshman course. Messrs. R. T. Fitzhugh and C. B. Hale of the University of Maryland reported in 1938 ("The Maryland Plan," in *School and Society*, September 3) that of forty-seven institutions they studied by means of questionnaires, only four exempted students from freshman English.

The Campbell report makes the significant remark that most of the criticism of freshman English is aimed at the sort of course that emphasizes drill in the so-called mechanics of writing. "If freshman English be regarded as devoted primarily to the elimination of errors in style, the movement to excuse all students who write respectably and even to abolish the course, requiring those needing training in mastery of the conventions to gain it without obtaining college credit for their practice, is a logical one."

Those who believe that freshman composition should stimulate thinking and adequate expression through systematic work in writing will, if they are to be consistent, either exclude unprepared freshmen or put them in remedial courses. If admission to college is so easy that a large percentage of the entering freshmen need drill in what is admitted to be high school material—spelling, grammar, punctuation, the elements of sentence structure, and simple composition—the choices are as follows:

(*a*) To apply the drill-for-mechanical-skill theory in all sections —presumably upon the theory that we must save the weak and let the strong look out for themselves.
(*b*) To section the students and apply the thought-and-expression theory to the high group, the drill-for-mechanical-skill theory to the low group, and either theory or a blend of the two to the larger middle group.
(*c*) To make such a compromise between the two theories as the stubborn facts require.

Compromise practice is very common, especially in state-supported institutions that have too little choice among applicants

certified by accredited high schools. It is obvious that a teacher who finds unprepared students in his sections and cannot get them removed to trailer sections or remedial courses must do as well as he can with them in the regular course.

As might have been expected, answers to the English Committee questions favor in general a compromise opinion—that although drill in grammar and other matters of form is necessary, freshman English composition should be much more than drill in the so-called mechanics of writing. It is a commonplace that we must not only help the student establish the habit of using correct English but also see that he thinks well, makes orderly composition plans, and writes simple, clear, straightforward, and reasonably effective English. The frequency of remarks in favor of composition material related to the student's major field of interest indicates that the writers consider English composition much more than drill in a vacuum.

Happy the colleges that can exclude the semiliterates. The more numerous English departments that must care for scores or hundreds of unprepared students duly certified for admission to college must steer a difficult course between two evils—spending precious time reviewing high school material, or teaching over the heads of perhaps a third of their students. Unfortunately there is good evidence that poor preparation for college English is a nation-wide problem. To quote Messrs. Fitzhugh and Hale once more: "It would seem inescapable from this liberal canvass of state universities that large numbers of students everywhere enter with seriously deficient training in grammar, usage, and composition, and that the universities in self-defense are being forced to do the work of the secondary schools. Why should this be so? It is easy to lay blame on the harassed high-school English teacher, but does it not really rest upon those who plan curricula and assume that children speak and write correct English by instinct? And is it too much to say that faulty training in English composition is the one glaring nation-wide failure of our public school system?"

Strong words, but no stronger than those in a private letter to the writer of this chapter from a dean of engineering who is not being elsewhere quoted: "So far as I have been able to analyze the difficulty, it goes back to the activities of the so-called educationists, whose half-baked theories of child psychology have operated in the direction of removing nearly all traces of discipline from preparatory school work. I know that up in our part of the country the so-called grammar schools no longer teach grammar and the high schools give the students no practice in composition. The result is that our own freshman classes are engaged in such subjects as diagramming of sentences and parsing of words—subjects which

in my elementary school days were taught to me before I was twelve years of age. Any reform that is to be made will have to take the direction of replacing the people who now dictate the teaching policy; and I know that this will not be an easy undertaking."

Our English Committee material makes it clear that a common and apparently necessary compromise between the rival theories outlined in the Campbell report is a differentiation between first-semester work (largely grammar and mechanics) and more advanced work in the second semester, with increased emphasis on thought and composition.

Let there be no mistake about the very common practice of including grammar drill in the freshman course. If the students need such drill, no theory ought to stand in the way of our giving it or seeing that it is given; but the necessity of drill in the rudiments of grammar and usage arises from an evil state of affairs that ought to be remedied.

The following remark from Professor Homer N. Nugent of the Rensselaer Polytechnic Institute throws doubt on the assumption that English departments must give the kind of drill to which the Campbell report objects: "One of our most interesting experiments has been to devote very little time to the teaching of elementary mechanics such as spelling, punctuation, and sentence structure. Students are required to make up their deficiencies so that class instruction may be devoted to the selection, organization, and presentation of material. Since this policy was adopted some ten years ago, the percentage of students passing the course has increased rather than decreased, although the same high standards of correctness have been maintained."

Subject Matter of English Composition

The Campbell report, which strongly recommends that freshman composition be systematic work in thinking and expression, outlines three alternative and competing suggestions concerning subject matter, toward which suggestions an eclectic attitude may be wise.

1. That for the average English instructor the best topics for composition are those that are drawn from the teacher's special field, English literature.
2. That composition must concern itself with the whole thought-world of the student, which in all probability is not that of English literature.
3. That the freshman's work in English composition should be correlated with other courses in his curriculum, such as freshman courses in history, economics, and literature. "Accord-

ing to this scheme, the various sections of freshman composition would be taught by instructors trained in both English and some one of these suggested fields. The student could thus choose as his section the one most closely related to his interests and his general educational program."

The suggestion that English literature be used as the chief source of material for papers is farther from the minds of those who have answered the English Committee questions than the second, which recognizes that many of our students are unfamiliar with English literature. Many whose opinions are worth heeding believe that engineering freshmen should write on subjects related to their major subjects—to which opinion Professor Karl O. Thompson and other members of the English staff at Case School of Applied Science raise the formidable objection that freshman students are not well enough acquainted with engineering to use technical subject matter. Others believe that our freshmen will be better educated if they are encouraged to write about matters that equally concern future lawyers or business men. No doubt all would agree that our problem is to get our students to write purposeful and not perfunctory papers; but unfortunately there is no magic formula for this important enterprise.

Though there is a strong current of humanistic opinion in every group that answered the English Committee queries, there are some that would reduce English composition to scientific or popular exposition, engineering reports, and business letters; and some would reduce literature, so far as composition courses are concerned, to material closely related to science, business, and engineering. Those who take the radically "practical" view may well heed the following entry in the Report of Conferences at the S. P. E. E. session of 1938 (JOURNAL OF ENGINEERING EDUCATION, November, 1938, p. 196): "The papers read by Dean H. P. Hammond, President Karl T. Compton, Dean O. J. Ferguson, and Professor F. B. Seely, as well as one by a representative of teachers of English, Professor J. Raymond Derby, showed that schools of engineering look to the departments of English not merely for training students in correct and effective expression in speech and writing but also for introducing them to the aesthetic and social values of literature and the related arts." If it be objected that this remark applies only to literature and not also to English composition, the answer is that books of readings and library assignments are commonly used as adjuncts to handbooks or rhetorics in composition courses, and also that good reading and good writing are closely interrelated.

Two variations of the third composition plan listed in the

Campbell report, either one serving the purpose of correlating freshman composition with other freshman courses, are as follows: (*a*) Professor Alvin Eurich's suggestion that teachers of English coöperate with each departmental division instead of conducting separate classes in English composition, but continue to be members of the English staff, and (*b*) Professor Campbell's own suggestion that "each student be assigned to a tutor in composition to whom he would bring all his written work throughout his college course for comment and advice."

Objections to the two forms of the third plan will suggest themselves—the difficulty of finding teachers who are well trained not only in English but also in another field, and the cost and administrative difficulty of brigading English teachers with other departments or of supporting a tutorial system. To what extent such plans have been tried in freshman work is not made clear by the answers to the committee queries. In such advanced courses as technical writing, as Professor A. M. Fountain has shown ("A Study of Courses in Technical Writing," 1938), some institutions actually have systems of interdepartmental coöperation. For example, says Professor Fountain, "one of the most common plans of joint effort between English and technical courses is that of a conference between instructors in the two departments, and the choosing of topics for papers to be written through the term. Colorado State, Delaware, Idaho, Maine, M. I. T., Montana State, Oregon State, and Rose Polytechnic Institute use such methods. In addition, at Delaware, the purely technical papers are frequently submitted to the English department for checking and review. . . . At M. I. T. the technical instructors not only aid in a choice of subject matter, but also frequently attend English class and join in criticism of the material offered."

Requirements and Electives

According to Professor A. M. Fountain's study above cited, the average English composition requirements in 117 schools of engineering that hold institutional memberships in the S. P. E. E. are as follows, the units being quarter-hours: elementary composition, 7.40; advanced composition, .59; technical writing, 1.40; business English, .11; journalism, .03—making a total of 9.53. (Additional English courses—literature with 2.75 quarter-hours and public speaking with 1.20—make the average English total 13.48 quarter hours.) The fact that elementary composition occupies 7.40 of the 9.53 composition units is evidence that freshman composition is well entrenched; second in importance among composition courses is technical writing.

The most important fact concerning English electives is that

engineering curricula are too crowded to leave much room for them. Beyond this statement of familiar fact, no quantitative statement is warranted by the available material.

Amount and Kinds of Writing Required

Many of the answers to the English Committee questions are in such general terms that no quantitative general statement of a standard amount of writing is possible, and obviously the amount of paper work that can be carefully read by the teacher and discussed with him in a private conference will vary with teaching loads. Specimen answers are as follows: 5,000 words a year; one long paper each quarter and one to three short papers each week; weekly themes and reports on reading; thirteen short papers and one 1,500-word paper in the first semester, six 500-word papers in the second semester; "much written work," whatever that may mean; home and class themes (number not specified), greater weight being given to class themes. The last entry is a recognition of the ubiquitous ghost writer about whom many of us have heard too much.

It appears to be generally agreed that exposition, popular or scientific, is the most important type of writing in the unspecialized composition course, with argument second. There are only scattered remarks in favor of the other types, with the exception only of letters.

Private Conferences

Answers to the committee queries yield so little quantitative information that one can only say that conferences with students in English composition are commonly considered necessary and that systems of conferences are nearly universal. "The conference system," says Professor S. M. Tucker of the Polytechnic Institute of Brooklyn, "is essential. Instruction in the classroom is generalized; the conference develops the individual student."

It must be added that in certain institutions conference work is hampered by lack of convenient and reasonably private staff rooms and by heavy teaching loads or by heavy student curricula. An experienced teacher in a college that has no obligatory system of conferences remarks that weak students who are on the edge of failing are more ready to come than the able students who are better worth the teacher's time.

Handling Special Groups of Students

Answers to the English Committee queries warrant only the broadest statements—that sectioning on the basis of ability and

preparation is employed here and there, perhaps more widely than the answers show, and that a few institutions exempt well prepared students from part or all of the usual freshman requirement or from an advanced course that is usually prescribed. For example, Professor H. L. Creek reports from Purdue University that "freshmen with the best preparation and ability—nearly one-third of the total number—are assigned to a more advanced course in composition in which there is relatively little attention to the mechanics of writing except in connection with themes, the emphasis being upon longer papers, upon originality of thought and style, and upon contemporary literature as a source of ideas. Students who do well in this course are excused from further required composition."

Though there is no uniform practice concerning unprepared freshmen, we are informed by Messrs. Fitzhugh and Hale (article cited above) that of forty-seven universities reporting, thirty-seven offer remedial work of some sort for students with deficiencies in English. "Of the thirty-eight universities which give prognostic tests, twenty-eight place deficient students in special sections, seventeen permitting no credit and eleven allowing credit under certain circumstances." Elsewhere in the same article Messrs. Fitzhugh and Hale list as follows the purposes underlying the various schemes for handling deficient students: "(1) To select the dull and unprepared; (2) to give them necessary training under more efficient conditions than prevail for them in the regular courses; (3) to give credit to those who improve; (4) to keep the worst from contaminating the others and seriously reducing the efficiency of instruction (it is the opinion of our freshman English staff that achievement of this end alone would justify the special sections); (5) to allow for correction of test results; (6) to give the eminently superior (2 per cent to 5 per cent) a freer hand in flying sections."

Where admissions are controlled, the problem of the unprepared student need not be serious. Where admission is by high-school certificate with no validating examination, the problem may be so acute that only heroic measures can meet the situation.

Promising Experiments

A few of the more interesting experiments in the teaching of English composition are worth citing. The first of these is the Florida plan of laboratory work, outlined in the *English Journal* for May, 1937. "The comprehensive Freshman English course of the General College of the University of Florida," says the course chairman (Professor J. Hooper Wise), "requires five class hours per week, distributed as follows: one in lecture sections, two

in discussion groups, and two in the Writing Laboratory. The course has for its basic aims the engendering of the ability to get the meaning from the printed page with a more than average rate of speed, to enjoy good writing, and to communicate ideas effectively in both oral and written discourse." Features not already mentioned are capitalizing on student interests, systematic work on vocabulary, lectures on timely topics (in large groups) and subsequent discussion of the lectures in groups of about thirty students; systematic tests of the student's progress; use of motion pictures as an introduction to drama; study of various literary forms—short story, biography, novel, poetry—after a careful and persuasive approach; much parallel reading; a writing laboratory with ten tables (six students at each), good lighting, and necessary reference books; practice in oral communication, with the aid of a speech clinic for students who need its services; and finally a comprehensive examination, about 75 per cent objective, intended to measure the student's ability to read, write, and speak.

The University of Washington reports an experiment in cooperation. "Housing the English offices within the engineering group has indicated to students that the subject has some standing; the correction of technical papers, effectively carried on during the first two years of the course, has greatly improved their written work and has thus increased the proportion passing the sophomore test for admission to the required course in English usually taken near the beginning of the junior year. Attendance of the English instructors at the meetings of the engineering faculty has developed a sense of responsibility to the college, and some appreciation of the engineering point of view. . . . The instructor's library, supplemented through University funds, has made possible a wide variety of contacts."

Professor Burges Johnson of Union College writes as follows: "In freshman English . . . we permit *no* sections *larger* than twenty-four, and hope to reduce this to twenty. These are conducted in seminar fashion, the students sitting around tables, and a great deal of discussion of student papers by fellow students is encouraged. One peculiar feature of our work is the requirement every little while that students shall set down on paper a condensed statement of their ideas on a given subject in the classroom *in ten minutes*, with no forewarning. These papers are then collected and with the aid of a lantern are projected on the wall in a semi-darkened room, and the members of the class call out criticisms of spelling, grammatical usage, clarity, and good taste. The students seem to dread this ordeal far more than the criticism of a teacher, and write as well and as clearly as they can in these tests. We

are able to take each student's work through the year and study his progress when writing under such difficult conditions."

Under the heading "Attempts to Stimulate Interest in English," Professor H. A. Nugent of the Rensselaer Polytechnic Institute says, "For some years, we have not felt the need of stressing the value of English, because our colleagues in other departments do it for us. . . . The fact that students are working on a graduating thesis at the time they are taking the course in applied composition makes them eager for the assistance they can derive from it. Moreover, the practical value of English is demonstrated to the students by the fact that members of the department supervise such activities as the debating club, the student publication, the dramatic club, and student announcing and broadcasting over our radio station."

How Effective Is Our Work in English Composition?

A categorical general answer would be the height of rashness. Witness the following citations. From an instructor in Brown University: "It is hardly necessary to admit that the work in composition is not 'as effective as might be desired.' It never is." From a dean of engineering: "The freshman work in composition has been fairly effective." From another dean: "Any institution satisfied that its work is 'as effective as might be desired' is certainly in a rut." The chairman of an English department answers, "No. We are always seeking to improve, and we vary our practices from time to time. Many difficulties need to be overcome; perhaps some of them cannot be. Aptitudes, special interests, prejudices, early environment, college tradition, weaknesses in pre-college training, an unwillingness to do the necessary laborious work in acquiring any real ability to write or speak—all these present obstacles to be faced."

The last citation is a reminder that the effectiveness of our work in composition depends partly on forces that are not entirely within our control. Some of these are teaching loads, the traditions and cultural atmosphere of the college, the size and efficiency of the library system, the presence or absence of such facilities as personnel departments and speech clinics, the quality of our students and the strength of their desire to do their English work well, the demands made upon students by subjects other than English and by extracurricular affairs, and the amount of help given by the staffs of other departments in encouraging the habitual use of sound and competent English. There is room here for discussion only of the last three.

How Good Are Our Engineering Students?

Evidence from every quarter, including the great Pennsylvania study ("The Student and His Knowledge," Carnegie Foundation, 1938), makes it clear that the colleges are getting many of the weaker graduates of high schools and missing many of the ablest. And we all know that many students bring to college stubborn bad habits of grammar, spelling, and pronunciation, and that many are slow or otherwise incompetent readers. To awaken all of these to an effective desire to remedy these deficiencies and to teach them the admittedly difficult art of writing is beyond human power. Habits cannot be remade by six semester hours of freshman English; some students are satisfied with their poor English; some are too busy with sports, amusements, or "activities" to take their English work seriously; some reject English that butters no bread (so they assume) in favor of civil engineering that promises a living.

Every college officer who has studied the results of prognostic tests in English knows that our students vary widely in knowledge of words, ability to read, knowledge of usage, and ability to think. To take an example from the Agricultural and Mechanical College of Texas, a test of spelling, punctuation, usage, and sentence structure given to freshmen in October, 1937, showed the following results: 1st decile, 26–66 of a possible 250 points; 2 decile, 67–78; . . . 9th, 147–166; 10th, 167–231. Of the students in the lowest fifth, only 23 per cent passed the first-semester freshman course, as against 97 per cent in the high fifth. Scores made a week later in a 150-word vocabulary test yielded nearly the same results.

It is impossible to reconcile the opinions reported to the Committee on English concerning engineering students in our English classes. For example: teaching engineering students is a thankless task; they are neither better nor worse than liberal arts students; they have more orderly minds than other students; "the engineering group . . . is in its general responsiveness and capacity the lowest group but one—optometry—with which our department has contact"; they are unresponsive because their minds are set against English. Since the answers disagree, one must turn once more to "The Student and His Knowledge": "The engineers, for whom a general test in liberal arts and sciences would appear as little appropriate as for any group, from a curricular point of view, score a trifle better than the A.B. group for which the test might be thought to have been designed" (p. 89). "The engineers . . . secured their creditable scores in the non-scientific subjects of the test in spite of an average of 79 hours spent in their technical curriculum and crowded chiefly into the two years immediately pre-

ceding the examination. To explain this, it is believed that the group is for the most part the result of unusual selection carefully maintained. Such minds naturally tend to learn more than merely what the curriculum requires; they are inclined to organize and to retain better than others what they learn. . . . More than any other single vocational division of the undergraduate population the group consists of fine minds that have an attractive 'place to go'" (p. 112).

Significant as this testimony is, it only shows that engineering students are relatively good. The sad fact is that many engineering freshmen are no better than weak students in other curricula.

That engineering students have little time for English is almost a commonplace. For example, the University of Washington reports that "the work in composition, literature, and speech has not been so effective as might be desired, largely because of the small amount of time and attention devoted to these subjects." At the University of Utah, the regular course of study is reported to be "so heavily loaded that it allows little time for electives." The extent to which sports and activities further reduce the time given to English is not within the matter of this chapter.

Are the Other Staffs Doing Their Share of the Work?

Nothing need be added to what Dean Hammond has said in the first chapter of this report concerning the recognized duty of the whole college staff to require good English in every paper and in class speech. Yet the fact is that in some institutions some of our colleagues neglect this duty and that some set a harmful example. Most of the answers to the English Committee queries either say nothing about coöperation in the enterprise of good English or else dismiss the subject with euphemisms such as "cordial relations" or "fairly good coöperation"; one writer speaks of strained relations between the English staff and the staffs of other departments; some deplore the evil example set by certain teachers of science or technology. If our colleagues hinder or fail to help, many of our students will resist our efforts and forget most of what they learn in our courses. Fortunate are the institutions—happily there are some—in which there is a tradition of coöperative effort and the necessary machinery for enforcement of a reasonable standard of good English.

It need hardly be said that we who teach English composition in colleges of engineering are far from satisfied with the results of our work. We cannot escape the conclusion that despite all we can do, many of our students resist the processes of education and fail to use what little they learn. It is disturbing to learn that

more than one institution finds elementary drill necessary even in the sophomore year. The plain fact is that no English staff, however gifted and diligent, can make good writers of all the freshmen who now manage to enter college. Perhaps the true measure of our success is the percentage of honor grades we can honestly report.

A Few Conclusions

Despite all that the answers to the English Committee questions have left uncertain, a few conclusions are safe:

1. That our freshman English composition courses are necessary, and that further courses in writing, not necessarily in the English department, are held by many to be desirable.
2. That many of our entering freshmen are so deplorably ignorant of English that we must spend much of our time in elementary drill for which no college credit ought to be given.
3. That the freshman composition course ought to be much more than drill in grammar and mechanics. It ought to call for competent thinking and systematic work in composition.
4. That the effectiveness of our work depends on much more than teachers and course plans, other major influences being teaching loads, curriculum loads, selection of students, and the attitude of the whole staff toward student English. This fact may well be brought as forcibly as possible to the attention of deans of engineering and heads of engineering departments.
5. That teachers of English composition have been and continue to be ready to coöperate with the staffs of other departments, and that we reasonably expect them to help us in the joint enterprise of helping students form good habits of thought and language.
6. That we need not yield to the demands of those who would drive the humanities from the campus. Those who stand high in the counsels of the S. P. E. E. agree that departments of English are expected to introduce their students to the "æsthetic and social values of literature and the related arts." How much of this can be done in the time and with the facilities at our disposal belongs largely to the later chapters of this report.

III

LITERATURE IN THE ENGINEERING COLLEGE

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I

Recently there have been two comprehensive surveys of the amount and type of English taught in engineering colleges. The authors of both studies have compiled statistics which show that more time is devoted to literature than to any other English course in the engineering curriculum except elementary composition.* Since these surveys supply all necessary data for those interested in the place and importance of literature in technical schools, this chapter will be confined to a discussion of opinions on the subject as gathered by the English Committee.

Replies, in answer to this Committee's inquiries, seem to indicate that most of those concerned with technical education favor including literature in the engineering curriculum. Of 242 people who replied, 196 commend its teaching; 23 emphasize that it is not so important as speech and composition, and 23 think that it may be omitted from the course of study. Although these figures were not systematically gathered, they seem to show that the majority of the group which answered the inquiry thinks literature should be taught in the engineering college.

Some representative statements by engineering educators may be quoted to show why literature courses are approved. Karl T. Compton of the Massachusetts Institute of Technology states: "As a cultural study it [literature] should broaden the engineering student's acquaintance with the best thought in fields of human in-

* Creek, H. L. and McKee, J. H.—"English in Colleges of Engineering," *The English Journal*, Vol. XXI, 1932, pp. 818–828. Fountain, A. M.—*A Study of Courses in Technical Writing*, Bulletin No. 15, Engineering Experiment Station, North Carolina State College, Raleigh, N. C., May 1938. On page 49 of his recent book, Professor Fountain gives the following statistics: "The average requirement of English courses for engineering students in all the 117 institutions [the study was based on the curricula of the 117 institutional members of the S. P. E. E.] is 13.8 quarter-hours, apportioned as follows: elementary composition, 7.40 quarter-hours; literature, 2.75 quarter-hours; technical writing, 1.40 quarter-hours; public speaking, 1.20 quarter-hours; advanced composition, 0.59 quarter-hours; business English, 0.11 quarter-hours; journalism, 0.03 quarter-hours."

terest not specifically related to his professional work." Franklin Thomas of the California Institute of Technology observes that every engineer needs a course in literature "to enrich his life, and to enable him to associate on a comparable basis with other college trained men." F. E. Ayer of the University of Akron remarks that literature should be taught "better to enable the engineer to enjoy his spare time." H. P. Hammond of the Pennsylvania State College also recommends literature courses because they enable a student to form good reading habits and, indirectly, to develop a clear, or even elegant, style.

In the opinion of graduates there are numerous reasons for studying literature. G. A. Peacock says: "Particularly in the mining profession, where years on end may be spent by the engineer in so called 'jungle camps' whose society dissects the graduate for his social assets, both literature and speech are primary requirements to his success. Hence the importance of English in an engineering school cannot be lightly spurned." M. L. Hurni remarks: "I feel that interpretative courses in literature are exceedingly important—a bit of Wilder's gentle melancholy, some of Nietzche's violent pessimism, a few of Anatole France's sharp barbs, a little of Galsworthy's brutal realism, and certainly a purgative dose of G. B. Shaw, each with ample footnotes. . . ." According to R. J. Exter, literature should be taught because "engineers should aspire to higher positions (executive) where a fair cultural background is expected." And Clayton Wright suggests that literature is desirable because it will "prod" a student into "forming good reading habits. . . ."

Some of the personnel men make interesting observations on the importance of literature. Dennis O'Harrow of the State Planning Board of Indiana writes: "The engineering graduate should have a basic knowledge of literature that will enable him to meet members of the other professions as a cultural equal, not as a transplanted stevedore." E. M. Billings of the Eastman Kodak Company states: "It is generally agreed that the study of good literature is valuable as a broadening influence and as a contributing factor in improving the engineer's vocabulary and skill of expression. . . ." W. R. Allen of L. S. Ayres and Company tells the following anecdote to show why literature is important to the practicing engineer: "Perhaps you heard me say . . . that my father, while traveling in India a number of years ago, met some English engineers who were putting up a bridge in northern India. He asked why they did not use American engineers, and they very promptly said that while American engineers were undoubtedly the highest trained men in the world they were no fun on a job which required only four or five hours' work a day, due to the heat.

Much of their time in distant countries was involved in leisure, where men played games like chess, read poetry, and talked on the philosophers. American engineers who did not have such a background were distinct liabilities when far away from home. In short, they were no fun because they were not cultured."

The consensus is that literature should be studied because it (1) teaches a student to read with understanding, appreciation, and enjoyment; (2) broadens his intellectual horizon and breaks the stranglehold of the present; (3) helps him to use his leisure time to greater advantage; (4) encourages him to form good reading habits and develop a clear, even elegant, style; and (5) enables him to attain an acceptable cultural level.

There must not be overlooked, however, the opinions of a minority group disagreeing with these conclusions. The case for those who do not regard literature as particularly important is presented by E. B. Norris of the Virginia Polytechnic Institute who says: "I do not believe that courses in literature as such are worth the time devoted to them, certainly not when the material used is of the usual type. Appreciation of literary quality must first be preceded by an interest in the subject matter, lacking which such courses are lifeless and useless. There is real literary merit in many scientific and engineering documents but try to convince an English teacher of that fact!" Dean Norris suggests more emphasis on grammar, spelling, punctuation, and composition and the "elimination of any attempt to teach 'literature,' the accomplishment in which is at least doubtful, if not wholly negligible."

Others in this group mention problems which worry them and make them wonder whether literature, as taught, is worth the time devoted to it. For instance, Thorndike Saville of New York University finds that the English professors do not agree with him on the type of literature which should be taught to engineering students. "We believe that one cannot and should not expect a student of scientific temperament to become enthusiastic over the literary classics which would appeal to a student majoring in English literature. On the other hand, there are many literary classics which would appeal to a student of scientific temperament, but it has been our experience that English instructors have on more than one occasion actually gone out of their way to prevent a student from reading such books as Huxley's 'Man's Place in Nature.'" At the risk of digressing, the writer wishes to point out that administrative officers seem to be encountering most of their problems because they cannot agree with the English professors on the type of material to be used in the literature course. Many of the deans do not object so much to literature as to the way in which it is taught.

Some graduates are also convinced that literature is unnecessary. G. W. Hintgen observes: "The high schools give the engineering student enough English literature without being forced into more!" David Clark remarks: "I do not feel that instruction in literature is important." And P. A. Washer says that it "would be better to concentrate on composition and on speaking rather than to consume time in the study of literature."

M. J. Maiers of the Commonwealth Edison Company speaks for the personnel men who do not recommend the teaching of literature: "I . . . have a faint suspicion that the young men selecting engineering do so, in some measure at least, to get away from the English literature. To include any appreciable amount of literature in an engineering course might cause this group to look for other fields where literature is less dominant." John F. Luhrs of the Bailey Motor Company makes the interesting point that, although the engineering student needs a broader training, literature does not offer a satisfactory medium.

From the preceding comments, it is obvious that a minority does not favor the teaching of literature in the engineering school. It objects to including the subject in the curriculum for the following reasons: (1) literature courses, as such, are not worth the time devoted to them; (2) engineers and teachers of English disagree on the type of literature to be taught; (3) students with a scientific turn of mind have little interest in literature.

In some of the replies from the engineering educators, engineers, personnel men, and recent graduates there are suggestions as to the kind of course in literature for technical students. W. P. Graham of Syracuse University epitomizes the opinions of many in the group when he states: "Whether the study of literature is effective depends upon how it is taught. If the approach is *critical,* the engineering student is not likely to derive much benefit from it. If it is *inspirational,* the student is likely to be interested and to benefit. If he gets a glimpse of literature as reflecting contemporary 'race philosophy' at different epochs, he is likely to acquire habits of thought which will be of value to him all through life." W. S. Rodman of the University of Virginia believes that literature should be taught but that the course should be so arranged as to present "outstanding writers rather than to subject engineering students to the usual type of survey which attempts to span the entire fields of English and American literature." R. C. Disque of Drexel Institute criticizes the courses now offered because the "prescribed readings . . . include too many things in which the student has very little interest." C. A. Dykstra of the University of Wisconsin suggests that above everything else the course in literature should teach engineering students to read well.

Several of those who expressed opinions on this point are in favor of including material that stresses the engineering approach. J. A. Bradley of the Newark College of Engineering says: "I do not feel that the study of classical English literature is desirable in an engineering school. It has been tried at the Newark College of Engineering and abandoned in favor of work more pertinent to the development and culture of the engineer. It has been replaced in the oral presentation of short papers, in the more systematized practice of writing, in the reading of selections dealing with the history of science and engineering, and by a course in the History of Industrial Civilization." And Samuel W. Bradley of Yale University thinks that "reading should be varied enough to stimulate an interest in social and economic problems as they relate to engineering."

In the same vein are statements of recent graduates. Henry Escher, Jr., writes: "In the matter of literature, I feel strongly against any attempts to instill in engineering students an ability to criticize and analyze academically what they read. . . . If an engineer never learns the difference between iambic pentameter and trochaic trimeter, he probably will not suffer very much. . . . If an engineering school English department gives some training in reading, together with an opportunity to read broadly, I think nothing more can be expected of it in the matter of literature study." H. M. Peterson adds: "It is my contention that there is sufficient good literature dealing with engineering subjects to write a course which would be interesting and informative to the student."

These representative quotations illustrate the ideas of a majority of engineers and engineering educators about the best type of literature course for engineers. Their opinions may be summarized as follows: (1) Literature courses in an engineering school should be general and inspirational rather than critical. (2) A careful selection from the best writers is better than a narrowly specialized course in one type or period. (3) Engineering students will probably read more if the course in literature emphasizes material chosen from science and engineering. (4) The aim of every literature course should be to teach the student to *read* in the broadest meaning of the word.

II

In the preceding section there were summarized the opinions of administrative officers in technical colleges and of engineers. This section will present the views of those who teach literature to engineering students.

Some professors of English are inclined to believe that they would be more successful if they could obtain the coöperation of

their colleagues on the technical staff. For example, Robert M. Smith of Lehigh University says: "We need heads of engineering departments who are willing to give English and speech departments ample time for this work." And G. F. Taylor of Tulane University adds: "Despite enthusiastic . . . endorsement of the work in English by most of the influential members of the engineering staff, students continually find themselves under such heavy burdens of strictly technical work that they are indirectly encouraged to slight their work in English. . . . Although this does not necessitate any lowering of our standards . . . it does mean that a larger number of men do mediocre or grudging work. . . ."

Other professors, however, report the full coöperation of members of the engineering staff. C. F. Judy of the California Institute of Technology states that "all the effort [of the Department of Humanistic Studies] is well supported by the trustees and faculty of the Institute." C. H. Barnwell of the University of Alabama says: "The relation between the department of English and the college of engineering has always been very cordial." The writer, who is in charge of the School of English in the Department of Engineering at the University of Virginia, can also praise his colleagues for their coöperation; he believes that they really teach the English in the department because they emphasize the importance of the subject.

Apparently in some quarters there is little coöperation between the English and the technical staffs, while in others the two groups seem to have arrived at a satisfactory solution of their problems. Those who are having difficulty complain that the technical staff overloads the students with engineering work and does not allot sufficient time in the schedule to the humanities. Those who have made some progress toward solving their problem commend their engineering colleagues for lending ungrudging aid.

Some of the instructors in English think that engineering students do not ordinarily have much interest in literature. Sharon Brown of Brown University states: "Work in English literature is distinctly secondary. . . . Though it may seem a sweeping generalization, it is true that the scientific type of mind does not respond to the study of literature." C. W. Wilkinson of the Agricultural and Mechanical College of Texas declares: "If I try to teach literature or anything other than a 'practical' course—one the students think offers them immediate returns in rollars and cents—I always feel that I am trying to cram an unpalatable something into a squeamish stomach."

Other professors have had a different experience with scientific students, as their comments show: S. F. Pattison of the University of Arizona remarks: "My experience has been that the engineers

are well above the average in their literature interest." T. D. Bowman of the Pennsylvania State College observes: "In this field I have found the scientific student less responsive than the undergraduate specialist in English but somewhat more responsive than the average liberal arts or commerce and finance student encountered in the conventional survey course."

Also, it would seem, there are divergent opinions among the teachers of English who answered the English Committee's inquiry. One group finds that the student with the so-called "scientific mind" has little interest in literature; the other believes that he has as much interest in literature as the average student of liberal arts and of business courses.

It seems appropriate at this point in the discussion to examine the type of literature course now offered in technical schools. A study of the replies to the English Committee's letters of inquiry shows that of the 38 professors who mentioned the kind of literature courses they teach, 20 offer a survey and 18 teach a new type of work in literature which seems to them more adequately to meet the needs of the engineering students.

The following are representative statements by those who favor the survey course. T. D. Bowman of the Pennsylvania State College says: "I do not believe special types of courses in literature are necessary for engineering students." R. E. Clark of the Agricultural and Mechanical College of Texas observes: "Survey courses at the sophomore level seem to me to call for no more specialized treatment than for the non-engineer." And Donovan Pratt of Purdue University recommends, whenever practicable, more generalized rather than more specialized work in literature.

There are other teachers of English, however, who are not in favor of the conventional survey course. S. M. Tucker of the Polytechnic Institute of Brooklyn regards the "general survey course in English as an utter waste of time." William Braswell of Purdue University states: "I should not advise survey courses but those in which a few masterpieces are studied." Alexander Buchan of Washington University adds: "The history of literature has been tried, and abandoned, as being nauseating to the students." W. F. Scamman of the University of Maine feels that too many students are driven away from literature by "traditional formalized courses." From the statements given above, it is evident that some instructors have found the survey course in literature unsatisfactory for engineering students.

Courses which have been substituted for the survey are: (1) combination of history and literature; (2) great masterpieces; (3) modern literature and contemporary problems; (4) humanities with emphasis on wide reading.

Jesse R. Morgan of the Colorado School of Mines offers a combination course of literature and history; his main object is to give the student a "better understanding of literature and a sense of world values in society." P. B. McDonald of New York University says: "In our college teaching of literature and cultural backgrounds, we have found biography and fiction more popular than essays, poetry, and drama. A great deal of history has to be incorporated in such courses."

Several of the professors are now teaching a course in great masterpieces of the language instead of attempting in a survey to cover the whole field of English or American literature. S. M. Tucker of the Polytechnic Institute of Brooklyn outlines the objectives of the courses as taught in his department: "At the Polytechnic Institute of Brooklyn, the professors attempt to introduce the students to the masterpieces in the language: plays, short stories, and biographies are introduced into the sophomore reading course. Meticulous analysis is avoided; the purpose is to encourage students to read as widely as possible." Next year S. F. Pattison of the University of Arizona expects to teach a course in which he will deal with literary masterpieces. He hopes to stimulate interest in great literature by showing students the pleasure that may be derived from reading good books.

At some institutions the instructor in English has found that a course in modern literature and contemporary problems is preferable to the conventional type of survey. For example, J. W. Barley of the University of Missouri offers courses in modern literature both English and American with emphasis on "literature as a product and a record of society rather than as esthetics." W. F. Scamman of the University of Maine gives "Modern Literature" which is designed to "acquaint the student with contemporary literature, to give him an understanding of contemporary thought or philosophy, and to develop appreciation (in the sense of standards of evaluation) of literature." Arthur W. Peach of Norwich University uses the same type of course to give the student "some insight into the cultural forces of his day." G. D. Haefner of the Webb Institute of Naval Architecture remarks: "We attempt to give our students a deepened appreciation of the best in literature and to enable them to use such literature as a means of relating their work to the problems of life. . . . So far as the subject matter permits, these discussions [discussions are held in class] concentrate upon the important psychological, economic, and social problems which underlie the literary examples." It will be observed that these courses serve a dual purpose; to teach modern literature and to introduce the student to some of the problems of the modern world.

In several engineering schools the humanities course has replaced the survey. At Union College, Burges Johnson and his colleagues are now teaching a band of liberal courses "extending through the four years of engineering education and providing one course each year. . . . Required reading has for its purpose acquaintance with good books that are significant in the life of today; and practical efforts are made to start students in the setting up of their own individual libraries." Amy V. Hall of the University of Washington has fashioned a course which attempts to acquaint the student with a "broad outline of man's knowledge." The English department assumes "responsibility for introducing technical students to the four broad fields of human knowledge: (*a*) The Physical Environment: the earth, astronomically and geologically; forces now active. (*b*) The Biological Environment: life, plant and animal; Man, from the standpoint of anthropology and of psychology. (*c*) The Social Environment: human institutions. (*d*) The Cultural Environment: ideas of leaders in art, literature, and philosophy." Apparently some teachers of English in engineering schools have abandoned the survey course and are now emphasizing the humanities as a whole instead of English or American literature.

The preceding paragraphs have recorded some typical instances of teachers who have abandoned the traditional survey and developed courses more suitable to the needs of their particular departments. Out of these experiments there may arise a new kind of course which will be satisfactory both to engineers and to English professors. If not, these pioneers will at least deserve the praise of their colleagues for having attempted to teach English in a new and a stimulating way.

Methods used by professors of English to encourage engineering students to read can receive only brief mention here; and that is regrettable, for many of them are interesting.

In one institution, the professors of English, recognizing that engineering students have little time to read during the winter, have arranged a course entitled "Summer Reading." The English staff supplies a list of acceptable books from which the student may read during the summer vacation. In the autumn if he submits satisfactory reports, he receives elective credit for the summer's reading. In another engineering school, the instructors permit a student to compile a bibliography on a subject in which he is interested. Once an acceptable list has been made, the student begins reading and continues until he has finished the necessary books. Then he reports his findings and is given elective credit if he shows a grasp of the material covered. Another professor encourages students to read by inviting prominent people to talk to

the class on "Books I Read for Pleasure." Often students will choose their parallel reading from the titles mentioned in these discussions. At another institution, an alumnus has come to the aid of the English teachers by offering a hundred dollar prize to the senior making the best collection of books for a personal library during his four years in school. These are only a few of the methods which are being tried by alert teachers of English in engineering schools, but these are sufficient to prove that some professors have accepted the challenge and are bringing imagination and enthusiasm to their task.

III

From the representative opinions of engineering educators, of practicing engineers, of personnel men, and of recent graduates, a majority is found in favor of teaching literature in the technical school. These groups believe that such a course enables a student to read with appreciation and with understanding, broadens his intellectual horizon, and helps him attain an acceptable cultural level. There is a minority group who do not consider literature important. The engineers are also convinced that literature courses should be inspirational and should serve as an introduction to the humanities; in their judgment, English teachers often miss the mark because they become too analytical and too specialized.

The English instructors disagree on the amount of interest the engineering student has in literature. Some believe that he responds as readily as does the average college student who is not specializing in English; others think that he is too interested in the sciences to pay much attention to literature.

There is no agreement among the English teachers concerning the amount of coöperation they receive from the technical staff. One group thinks the engineering faculty could be of more assistance; the other commends the engineering staff for giving all the aid that could reasonably be expected.

In the statements of the English professors there also appears a disagreement as to the type of course which should be offered. Some continue to teach the traditional survey, and others offer new courses which seem to them more adequately to meet the needs of their students.

The one significant conclusion which can be drawn from the material gathered by the Committee is that most of the engineers and most of the English teachers, though they disagree at points, are convinced that the graduate of an engineering school should have both adequate technical information and an appreciation of the part that literature can play in the life of an educated man. Both groups are almost unanimous in their opinion that literature must be included in the engineering curriculum.

IV

SPEECH TRAINING IN COLLEGES OF ENGINEERING*

By DONALD HAYWORTH

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This chapter is a critique of seven hundred letters and questionnaires which the Committee on English received from students of engineering who have studied speech, graduates of engineering colleges, teachers of English and speech (including heads of departments), and administrative officers.

I

Student Opinion

Twelve representative institutions returned 335 questionnaires from students now in college who have taken speech. Although the speech courses in these institutions varied considerably in length, they followed, almost without exception, the generally recognized practices of teaching beginning public speaking: use of a modern, standard textbook; careful attention to outlining; utilization of the class hour almost wholly for speaking, but with criticism by the instructor and members of the class.

Since the first two questions of the questionnaire were asked for the purpose of evaluating the student's ability to give a judgment, we may begin with the answers to the third question.

Question 3: Would you favor changing the aim of the course?

Only eight of the 335 favored changes in the aim of the course. But when these eight suggestions are analyzed it is seen that they are really directed at methodology, rather than at the educational objective. Apparently every student believes that an engineer should be able to speak well in public.

Question 4: What suggestions have you for improving the method of instruction in speech?

In considering these suggestions the fact should be held constantly in mind that most students formulated no complaints. It

* This study was prepared with the coöperation of the National Association of Teachers of Speech.

may reasonably be assumed, however, that many of them would agree with the suggestions that were made. For convenience, the suggestions may be classified in the following categories:

a. Students should give more speeches. This specific comment was made by 43 students. In the institutions studied the number of speeches ranges from seven to seventeen. In many institutions there is an effort to get each student on his feet once a week. Apparently, however, this is not often achieved. The total number of speeches seems to average about ten for a course of eighteen weeks, meeting three times a week. Several students suggested shorter and more frequent speeches. In view of the answers to the questionnaires and the practices in the various institutions, it seems that in order to satisfy students the course of average length should have at least twelve or fifteen speeches.

b. Sections should be smaller. This was the protest of 38 students. It seems that sections run between twenty and thirty, except at two institutions where they are restricted to about fifteen. Only at these two institutions was there no complaint as to size of sections. At the same time, many students wanted the experience of speaking to larger groups. Recognizing that the two features are incompatible, they invariably prefer smaller sections.

c. The public speaking course should be longer. The courses studied ranged from one and one-third semester hours to six semester hours, the typical being three semester hours. There were fourteen students who wanted the course lengthened. Several students suggested that the amount of time allotted public speaking should be doubled, thus making it a year course of three hours each week.

d. Not enough individual criticism of speeches. This was a complaint of 32 individuals. In those answers in which a reason was given, the fact that sections were so large, or that the course was so short, was given as the reason.

Looking back over the four complaints listed above, one will see that they all arise from a *lack of sufficient instructional force.* When 105 students out of 304, all answering their questionnaires alone and in widely scattered institutions, think first of this one complaint, it is apparent that their grievance should be recognized. Only the administrators can provide the answer.

Nevertheless, speech instructors cannot go entirely free. Students have some complaints on teaching procedures as well as some valuable suggestions.

e. Less emphasis should be given theory. This took many forms: "Too much outside reading"; "written work not practical"; "less emphasis in grading should be given to tests and writ-

ten work"; "textbook not useful in the course"; "too much routine 'made' work"; "ought to have more work on delivery." Some seemed especially bitter about doing a great deal of what they believed was unproductive work. This complaint appeared in one form or another often enough for us to take it seriously. Students are apparently not convinced that outside reading, or that the written work, such as notebooks, is of any real value. One of two things must be true: either the assignments in question are unwise, or more attention should be given to motivation.

f. Discuss the text more. Only a few students were disappointed with their texts. There were many more complaints that the text was not discussed enough and was not related to the classwork. Undoubtedly, this is a significant point and may partly explain the preceding criticism. Those of us who teach in the field know how easy it is to assume that the reading of the text is something that can be done without guidance; or we can become so much interested in the day's speeches that we ignore the reading we have asked our students to do. The study of theory may thus become divorced in the student's mind from speaking practice and seem to be mere "busy work."

g. Use a recording device. Where voices are systematically recorded, students greatly appreciate it, and in those institutions in which this has not been done there is an occasional student who sees voice recording as the great need in the course.

h. Provide more opportunity for private conferences. Eight students felt unable to solve their problems in a class. They wanted private conferences with the instructor. No information is available as to the amount of conference work now being done.

i. Impromptu speaking should be increased. Thirteen students would like to have more impromptu speaking. They feel that prepared speeches are desirable, but that much of an engineer's speaking will be without preparation for the occasion.

j. The questionnaires also elicited a miscellany of suggestions which occurred two or three times each. Some are pertinent, as for example: exchange students between sections in order to give an unfamiliar audience; more emphasis on reducing stage fright; more instruction in conversational speaking as opposed to public speaking; give practice in conducting an open forum; assign more technical speeches. Others merely reflect general attitudes, such as: too much work; insist on better speeches; not enough persuasive speaking; too advanced. Two students suggest that moving pictures be taken of students while speaking, and one urges that instructors do less "lecturing" but instead give short speeches to the class occasionally to demonstrate good technique.

Question 5: Do you believe speech should be required in engineering colleges?

Affirmative answers totalled 241, 9 were undecided, and 16 were in the negative. Answers were frequently made most emphatic with such phrases as "Most emphatically, YES"; "Absolutely!"; "Yes, we all need help." Of the negative answers, seven were from one institution which furnished 23 questionnaires. But even in this institution the negative answers were usually qualified by the statement that speech should be an elective. The most casual survey of the opinions of these students reveals the unquestionable enthusiasm of students for the work.

Question 6: Compared with other non-engineering subjects in the curriculum, how would you rate the value to you of *your* course in speech?

One of the least valuable	16
Slightly under average value	16
Average value	40
Slightly above average value	68
One of the most valuable	137

Since these answers were made by check marks, an examination of the questionnaires as filled out reveals nothing beyond the figures.

Question 7: In what year in college would you have it placed?

(Note: The figures in the first column represent the answer to this question. The figures in the second column show when the students themselves took the course.)

Freshman	91	76
Sophomore	109	120
Junior	71	65
Senior	39	54

It is rather surprising to observe how closely the two columns correlate. Examination of the questionnaires reveals that students tend to believe that the year in which they took the course is the best year.

Question 8: Did your course in speech have any effect on your writing ability?

Question 9: Did your course in composition have any effect on your speaking ability?

These questions may well be dealt with together. The statistical results of the questions are:

	Yes	Perhaps	No
Effect of instruction in speech on writing	132	33	106
Effect of instruction in composition on speaking	173	25	64

Apparently this tends to show that instruction in composition has a greater effect on speaking ability than has speech instruction on the ability to write. But since a large proportion of the answers indicated that speech was taken after the course in composition, it is difficult to know what the relation would have been if the order had been reversed.

The item most frequently mentioned was in respect to organization. Fifty-six stated that their work in English had made speech outlining easier. Conversely, 50 found that instruction in speech made it easier for them to outline a subject to be developed in writing. A great many found the courses to be mutually helpful in this regard.

It was believed by fifteen that lucidity of oral expression was increased by instruction in writing, while eighteen found that there was a transfer of ability in lucid expression from the speech course to writing ability. There were 36 who stated that writing so expanded their vocabularies that it increased their effectiveness in public speaking. Exactly one-third of that number were of the opinion that a speech course enlarged their writing vocabularies. The course in English composition was given credit by 27 for improving their grammar and thus preparing them for better public speaking. Only one found that the public speaking course improved his grammar.

Speech instruction, in the opinion of 23, increased their ability to write by making them more aware of the reader. Previously they had not written with the reader in mind, but after taking speech they realized that the purpose of language, written or oral, is to achieve significance for the listener or reader as the case may be.

Quite frequently individuals stated most emphatically that there was no relationship between composition and speaking; while others just as emphatically claimed that the essential natures of the two were one and the same.

II

Opinions of Graduates

The committee's letter of inquiry was intended to evoke general comment, and the answers give a number of definite impressions. It was assumed by all of the 153 who replied that public speaking should be taught. Fifty-six volunteered the belief that it should be compulsory, and the other letters quite generally made the assumption. Only one suggested that it be an elective. Many said it should be extended, while no one believed it was over-emphasized.

It is very apparent that graduates look upon speech as public speaking, *i.e.*, a so-called practical course. Quite frequently they declare that they believe in the study of literature for its cultural value, but no one assumes that speech is or could be cultural. Speech instruction is apparently identified by many graduates with the techniques and aims of Dale Carnegie. The more nearly it fits that pattern the more it is appreciated. The only exception, and fundamentally this is no exception, was the occasional statement that conversational speaking (including the interview) should be taught—because it so *practical.*

Only one stated that English composition and speech should be taught together; in the main, the customary division of these two into separate courses under instructors with specialized training was accepted as more efficient. Other suggestions mentioned once or twice were:

Instructors in speech should have a background of business.
Most public speaking instruction in colleges is not practical.
Public speaking teachers emphasize delivery to the exclusion of subject matter.
Public speaking should be taught by men.
Extra-curricular activities should be encouraged.
Correction of speech defects should be provided.

A reading of the letters leaves the distinct impression that graduates of engineering colleges would like to see more instruction in public speaking, and that, in the main, they are sympathetic with the type of instruction now offered. It is very apparent that older graduates are less satisfied than are those of more recent years, a fact explained, no doubt, by the shift in speech instruction from the older "elocution" to the modern emphasis on "practical" speech-making.

III

Opinions of Instructors

Sixty-seven instructors of speech in engineering colleges answered requests for their opinions on five questions, as follows:

Question 1: What type of speech training, in your opinion, should be taught in engineering colleges? Please include in your answer comments on educational objectives, skills, knowledge, appreciation, etc.

Answers showed overwhelmingly the opinion that training in public speaking is considered preferable to any other type of instruction in the field of speech. General effectiveness in conversational speaking was mentioned by nine instructors. "Fundamen-

tals of speech" (a rather loose, general term, which is familiar to speech teachers as embracing such things as articulation, vocal quality, and pronunciation) was mentioned by only four. There was a scattering of such objectives as vocabulary building, parliamentary procedure, socialization of the personality, development of self-confidence, voice training, phonetics, anatomy of the organs used in speech, interviewing, and cultural development.

Question 2: How many term or semester hours do you think are needed to accomplish the above objectives?

Let us state this in the total number of hours of recitation, taking a term as twelve weeks, and a semester as eighteen weeks. Answers ranged from 36 (one term of three hours) to 162 (three semesters of three hours). It must be remembered that this range is due in great measure to differences in educational objectives. The instructor who asked for only 36 hours proposed to give no more than a brief introduction to a few kinds of public speaking situations. The instructor who asked for 162 hours proposed to overhaul with great thoroughness the whole personality as it is revealed in speech. Undoubtedly, too, the difference in sizes of sections was an important factor. In one institution instructors deal with groups of four to seven; elsewhere, undoubtedly, the assumption is that classes would consist of twenty-five or thirty.

The average length of course suggested by instructors was about 80 hours, which is equivalent to one semester of four hours, or a little more than two terms of two hours. Since most institutions operate on a semester plan, replies were usually expressed in semesters. The three most popular suggestions, ranking almost equally, were:

One semester of three hours (54 meetings).
Two semesters of two hours each semester (72 meetings).
Two semesters of three hours each semester (108 meetings).

We must point out that two opposing influences tended to operate in the minds of those who answered this question. First, they realized, as was so often stated, the fact that the engineering curriculum is extremely crowded; and second, they are speech teachers with a natural prejudice in favor of their own discipline.

Question 3: Please describe your course now being offered engineering students.

The answers showed almost the same results as were shown in the answers to the first question, namely, that the typical instruction in *public speaking,* as so widely taught throughout the entire

country, is being offered students of engineering. Such a finding would certainly not obtain in a survey of liberal arts colleges or teacher training institutions, for in both of those one would find much more instruction in "fundamentals."

Question 4: Do you know of any way in which your administration could help you make your work more effective than it is now?

This question brought only a few, scattered answers. Nearly all instructors of speech are apparently well satisfied with the cooperation of the administrators, and many are exceedingly vigorous in their appreciation. Below are listed the few scattered suggestions made by 67 instructors, with the frequency of reference in parentheses.

Make provision for more instructors and thereby smaller sections. (9)
Courses should be lengthened. (4)
Speech should be required. (2)
Buy sound recording equipment. (2)
Advisers should be more sympathetic to speech. (2)
Allow more election in advanced classes. (1)
Other instructors should require better speech in recitation. (1)

Question 5: In what way is the engineering faculty facilitating or using the work you are doing? What additional assistance or cooperation would be desired?

The head of one department emphasized the value of the moral support made evident through the offering by engineering faculty members and alumni of prizes for speech contests among engineering students. Frequent invitations to discuss the presentation of technical reports in engineering seminars and the preparation by instructors of engineering of technical bibliographies for use by speech students in the preparation of technical speeches were cited as evidences of cordial coöperation. Although no other mention was made of it, similar coöperation no doubt exists elsewhere. There seems to be scarcely any coördination of speech instruction with class work in engineering, however, and apparently no need of such coördination is felt.

IV

Opinions of Deans and Presidents

Letters were received from administrative officers of some seventy institutions. In nearly half of the institutions public speaking is offered, and in most of these it is required. Adminis-

trators of two institutions showed dissatisfaction with the work being done in public speaking. The great majority showed enthusiastic approval of the work done. No administrator advocated any decrease in speech, and a number advocated an extension of the work in this field.

In eighteen of these institutions there is no attempt to teach speech in any form and no pretense that it is taught. In twenty-two institutions the administrative officer says that there is a course in English, oral and written. Probably many of these institutions have courses in freshman English composition but actually no speech at all. Many college catalogues contain a statement to the effect that the freshman English course is devoted to "oral and written" composition, but the actual instruction minimizes the former; the speech instruction consists of a few "oral themes" or the informal discussion of selected topics rather than training in the sort of practical speech-making apparently desired by students and graduates. This is, of course, readily understandable when we realize that no English department has ever given graduate work to prepare teachers to coördinate the two. Even if administrators wish to have both composition and public speaking taught in the same course, they cannot find teachers trained to do the work.

In view of the apparent general satisfaction with speech training in institutions where it is offered, the absence of any speech instruction at all or the limited amount of it in more than a third of the engineering institutions reporting may well be questioned.

V

Conclusions

1. There is general approval of the present aims and practices in the teaching of public speaking.
2. There is no appreciable or general dissatisfaction with the instructors of public speaking.
3. Sections should be smaller—even though this takes more money. Probably English and speech are much more cheaply taught per credit hour than most engineering subjects, and large sections in public speaking not only thin the educational content, but waste the student's time. (One thing not often noted by administrators is that a public speaking instructor generally has "outside activities" to supervise—debates, plays, etc. If he carries this work in addition to a full teaching schedule he is likely to be overloaded. Without such duties it is usually fair to ask him to carry a slightly higher number of class hours than most instructors in other subjects.)

4. Public speaking should be required of engineering students. The composite opinion of students was that it should come about the sophomore year. However, it is the opinion of the author that it should be given in the freshman year—largely because of the belief that any changes in linguistic habits should come as early as possible. One graduate stated that a student should not be allowed to speak in public until he at least *knows* how to speak properly. But this may just as reasonably be reversed. Speech processes normally precede writing in childhood. How can anyone write with skill until he can speak the language with reasonable confidence?
5. Students, instructors, and graduates come into general agreement in suggesting a longer course in public speaking—perhaps a minimum of four hours for one semester with sections of eighteen. The amount of credit might be reduced to three. Instructors in public speaking would probably agree that classes should meet at least three times a week rather than less frequently over a longer period. One of the great weaknesses of the present "oral and written" combination is the attempt of many English instructors (not trained in or sympathetic with speech) to have "oral work" once a week. For at least half a dozen reasons such activity is a profitless waste of the student's time.
6. Little consideration has been given by anyone to the possibility of utilizing speech training as an instrument of cultural development. Probably this should not be done until more time has been found for the "practical" course.

V

TEACHERS OF ENGLISH IN ENGINEERING COLLEGES: SELECTION AND TRAINING

By H. L. CREEK

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The Complaints

Although some persons believe that the training in English for engineering students is successful, at many institutions there is enough dissatisfaction with the teachers of English to disturb complacency. This dissatisfaction is expressed both by educators and by engineering graduates, who suggest new criteria for selecting such teachers and modifications in their training. Their indictment and their suggestions will be studied in this chapter in an attempt to draw conclusions that may lead to action and improvement.

"The teachers who are giving this work are typical English teachers, . . . more imbued with literature, dramatics and English composition than with the phases of the work the engineer especially desires to obtain." This complaint of the dean in a Western land-grant college is representative of the widespread dissatisfaction which is voiced by some engineering deans and by the presidents of a few engineering colleges. "If our work is to be effective," says a dean in a state university, "we must have teachers with personality and some experience in the affairs of life. Furthermore, they must understand and sympathize with the family backgrounds and aspirations of the young men who compose their classes."

As the second quotation suggests, instructors in English are described as unwilling to become interested in the engineering students. Moreover, they appear to their critics as not of a sufficiently masculine type nor of enough experience in the world outside their books to command the respect of engineering students. And there is a belief that the standards of selection are too low. One dean comments: "The standards of selection of an English instructor should be just as high as those for [the teacher of] a technical subject."

The conviction that their teachers of English are impractical, not masculine enough, and unsympathetic is also expressed by many engineering graduates. Sometimes their defects are ascribed

to the post-graduate training of the English teacher. "Men trained in the graduate schools are most certainly unsatisfactory," writes an engineer from a Middle Western state university; "or at least the ones I had were. An instructor who glides into a class room and greets a class of engineers with a sweet schoolgirl smile and 'My, isn't this a beautiful spring morning?' hasn't a chance of teaching them anything." To one graduate his English instructor was "a budding pinko"; whereas he felt that "when a student embarks on engineering he has put aside—for a time at least—all ideas of revamping the social order and such-like." Engineering students and instructors in English are said to be cast in different molds; there can be no meeting of minds.*

Selection

The "practical" teacher. As a principal remedy for the prevalence of teachers of English who are effeminate, blind to the qualities and needs of the engineering students, and too narrowly interested in their special fields, many engineering deans and graduates suggest "practical" teachers. They think that the teaching could be improved if men with an engineering education, or at least with an engineering point of view, could be given special training for the purpose of teaching English to engineering students; or, the order of training might be reversed and an English teacher trained in the field of engineering. "I would say that we must decide whether it would be better to have an engineer, well versed in English and its requirements in the field of industry, teach English or whether an English teacher be trained in the field of engineering," is one comment. "If I understand correctly the consensus of our engineering faculty," writes another engineering administrator, "it is that the function of a department of English in a college of engineering would be to train the students so that they could handle language effectively in their business. There is great unanimity in the belief that this could be done most effectively by teachers who were both engineers and teachers of

* It is noticeable that most of these comments as well as others that will be found later in this chapter are based on the assumption that the engineering students are different from other students. What, if any, are the distinguishing characteristics of the engineering students? We have been told that they are practical, masculine, hard-headed persons with analytical minds, impatient with gush and emotion, unappreciative of poetry and the arts, which are regarded as feminine and sentimental. The conclusion drawn by some is that even the training in English must be adapted to these keen, hard, practical young men. Most teachers of English are agreed, however, that engineering students as students of English are not so different from students in a liberal arts college, if exception is made of the few liberal arts students who are specialists in literature or related fields, as to require a special kind of teacher.

English. It is also the belief that such teachers can be found and developed."

In their requirements for teachers of English the emphasis of engineering graduates is more on what they call "practical" knowledge than is that of the engineering administrators and somewhat less upon knowledge of engineering. They would like teachers with experience in industrial fields; practical men with knowledge of business or journalism; scientists or engineers with a background of writing reports, technical articles, and business correspondence. One graduate writes: "By all means find an engineer's English instructor from the ranks of engineers," but he adds that "a literary-minded engineer is a rare commodity" and "is impossible—like many an ideal." Many go farther and say that engineering training is not at all necessary. "The ideal instructor of English for an engineering college is a practical man who has had some experience in business and journalism," one man writes. "I do not think a knowledge of engineering or science is essential."

The "cultured" teacher. It would be misleading to imply that all or nearly all engineers or administrators are hostile to the usual "literary" type of instructor now found in the engineering college. Many deans and college presidents, as well as some engineering graduates, feel that what is needed is not a different type of instructor but a better instructor. The engineering administrators in particular have this attitude. "A man of enthusiasm and tact," writes one dean, "if he has knowledge of anything, can make himself interesting and work with others whose special field is different from his own, certainly on the elementary level of freshman English." And another head of an engineering school records his belief that "teachers of English to engineers should be discriminating if not (or and if possible) creative scholars in one or more fields of literature." Some presidents object vigorously to special teachers of English or a special kind of teaching of English for engineering students. They see no reason why either the teachers or the nature of the teaching should be different. An old Eastern university reports that it has always followed the policy of giving students of engineering much the same training as students in the other undergraduate schools. "In their courses in literature many students of engineering are stimulated by being in contact with students whose courses are directed toward other than scientific ends." "There is a more healthy interest and more helpful competition," says the president of a state university, "in classes where engineering students work alongside those who are preparing for medicine, law, business administration, home economics, and the like." Some of these presidents and deans are inclined to ascribe the inefficiency of English instruction as much

to lack of coöperation and support on the part of engineering faculties as to deficiencies in the English teachers themselves.

Some engineering graduates also oppose the "practical" or "engineering" type of instructor in English. In fact, an analysis of the replies to questionnaires shows almost equal numbers opposing and demanding the use of special instructors. There are engineering graduates who feel that "instructors in English should have an appreciation of the beauty in literature and poetry"; that they should be able to impress upon their engineering students "that a liberal education is to their ultimate advantage, and that in college they have time only for laying a broad general foundation." These graduates recognize that "engineering students are subject to enough technical pressure tending to atrophy their broader interests," and assert that "the instructor in English should be some one entirely removed from engineering knowledge, some one who thinks the world rotates around English and around literature." "Out of this," one states, "might come a happy balance for the strictly technical instructors, who as a rule have little regard for the English department."

Even an instructor of the dilettante type is described as "exceedingly helpful for the further enrichment of the engineering student's contacts with non-professional life." "The average engineering instructor, on the other hand, is either the sharp business-man type or else the bloodless variety; and exposure to the tired sophistication of the typical young English instructor provides not only a pleasant change but a heavy eye-opening shock." The graduates who make these replies apparently got something from their courses; or they took to them a background of greater culture than some of their fellows who looked only for immediate practicality. Perhaps the views of the more "liberal" engineering graduates can best be summarized by a quotation from the letter of a graduate who writes: "Instructors . . . should not be all of one type. Some should be schooled in the classics, others should have some knowledge of engineering or science, and some others have a journalistic or business background."

Attitudes in different parts of the country and different types of institutions. The opposing opinions of engineering graduates and also of engineering administrators seem to reflect the backgrounds from which they came or the atmosphere of their institutions. In the replies to the questionnaires almost none of the graduates of Eastern colleges of engineering insist upon engineering training or practical experience for their teachers of English, or upon courses especially adapted to engineering students. Apparently they assume that the traditional literary training of the ordinary college student is suitable also for the engineering stu-

dent. On the other hand, in the Middle West, and, perhaps to a still greater extent, in the Dakotas and Texas and other Western states, graduates feel strongly that engineers are a special type of persons and therefore require a special type of teacher of English in specialized courses.

A similar geographical difference of attitude is found among engineering administrators, although they generally demand that English teachers contribute to the "cultural" education of their students. Some of them, however, on the basis of the complaints they hear, are inclined to feel that "cultured" engineers would be more effective than the average product of a graduate school of English.

It may also be said that the complaints about instruction in English occur more frequently in the engineering colleges of large universities than in separate engineering schools or land-grant colleges, where technology is paramount. The reason appears to be that in the large universities the instructors are regarded as devoting most of their attention to the students in the college of liberal arts and taking the teaching of engineering students as a disagreeable "chore," whereas in engineering schools they must succeed with engineering students or confess themselves failures.

Approval of teachers of speech. There is little complaint about teachers of speech; and there is evidence that in general they seem more practical than teachers of composition and literature. As one president said, referring to his own institution, "It might be well if some of the introverts of the English staff had some of the qualities of the extroverts of the speech staff." Speech teachers, of course, have the advantage of becoming acquainted with students in the various extracurricular activities of debating, extempore speech contests, and dramatics, and in that way coming to a more friendly understanding with them. Moreover, almost all their teaching seems to have practical applications to the life work of the engineer. Some instructors who teach both composition and speech report a more sympathetic reception in their speech classes. On the other hand, there is some complaint—voiced mainly by teachers of English—that teachers of speech overemphasize the psychology of salesmanship and practical results and neglect both correctness of expression and the esthetic and moral aspects of communication. Since there is relatively little expressed dissatisfaction with instructors in speech, however, consideration in this chapter will be given only to teachers of English literature and composition.

Some conclusions about who should teach English. After surveying the contradictory views about what an instructor in English should be, the reader may think it impossible to satisfy

the engineering profession as a whole. But the possibility of some agreement is not so remote as may appear.

The principal suggestion for the improvement of English department staffs is the use of engineering graduates or of men with experience in business or journalism. In spite of some opinions to the contrary, most educators agree that it is neither desirable nor possible to form departments of English from engineering graduates. If the instructors are to be men with sufficient general cultivation and a training in English to command the respect of members of other departments, the engineering colleges cannot supply them. In the first place, the most capable engineering students, even when they show interest in writing and literature, do not want to become teachers of English. They are superior in engineering as well as in English; and the rewards of engineering loom much larger in their eyes than those of the most successful teachers of English. In the second place, the number of engineering graduates with ability to teach English is small. The letters received by the Committee on English from graduates, who are in the main superior graduates, show that. Also, the files of almost any head of a department of English prove that even the engineering graduates who do think they might like to teach English cannot write correct letters of application. And, when it is suggested that there might be a chance for them in departments of English if they would suitably prepare themselves by graduate training, few take the advice. Moreover, it would be just as impossible to recruit the ranks of teachers of English from journalism or business.

On the other hand, there is the commendable policy of certain institutions—the Iowa State College is one—of occasionally seeking instructors who have had engineering or other practical training or experience, and have also properly prepared themselves in English by graduate study. One or two such instructors in a staff often do a great deal to bridge the gap between the English faculty and the engineering faculty, and they may teach effectively the advanced courses in technical writing. They contribute ideas to the department and help train the younger instructors who have had only the liberal arts college and graduate school education. But their number is small and is not easily increased.

Apparently the only practical way of increasing the number would be for departments of English and engineering deans to select from their engineering students a few who appear to have the necessary qualities, see that they are properly supported during a period of training, and then provide suitable positions in English departments for them with the assurance that if they are successful a satisfactory career lies ahead. But it would be con-

trary to experience to conclude that such men would necessarily become the best teachers of English in engineering colleges. Many of the most capable and successful of English teachers know nothing of practical engineering or business, and have had the most literary of apprenticeships.

If the instructors in English must for the most part be persons whose primary interest is literature, either in appreciation or creation of it, then it is apparent that we shall get farther by selecting higher grade men and women of the "literary" kind than by devoting much energy to the hopeless task of finding enough capable "practical" teachers. By "higher grade" teachers we should mean not better technical scholars but better teachers, those with the personal qualities that will make them significant and interesting human beings, even to the engineering students whose primary interests are not literary. They should also have the right attitudes for working with engineers.

Training

If it is agreed that instructors, whether graduates in engineering or not, must be trained in graduate schools of English, what sort of training is most desirable? At this point the engineering college administrators are not very helpful. A dean of a state university does say, "I believe there should be some place in the country where a student interested in teaching English in engineering schools might go for his graduate work and receive definite training for his work," but he does not indicate what that training should be. It would seem that some deans believe that a very little training in English would go a long way if the instructor knew some engineering. The director of a school of mines is apparently of this opinion, for he hopes that his institution "some day might find an engineer . . . of broad training . . . who would be willing to forsake his engineering, brush up his English if necessary, and become a teacher of English in a technical school." Most administrators, however, believe that considerable training in English is necessary. One goes so far as to say, "The teachers of English in engineering schools should be holders of the doctorate, or they should have produced writings recognized as literature."

Objections to the Ph.D. training. Heads of departments of English have more concrete suggestions than the administrators, although some of them seem reasonably well satisfied with the present graduate instruction. One in a land-grant college writes: "The idea that graduate work in English unfits a man for teaching engineers is pure ignorance or prejudice, or both." On the other hand, a head in an Eastern technical college, well known for its successful work in English, says, "In this institution we all agree

that 'the training which the average instructor receives in the graduate school rather unfits him for his work.' Of course the untowardness of the result depends upon the personality of the instructor. In general, the experience is simply poisonous. Some men, to be sure, can live down their Ph.D.'s, and are not permanently injured. But, for the life of me, I cannot see that the degree, or the training that lies behind it, is of the slightest use practically to a *teacher*. In general it is a serious handicap. Preach this from the housetops and so help to destroy a vicious delusion. Teachers are not made in this way or by this method. On the other hand, the instructor should have had several really useful graduate courses in literature or composition for at least a year at some first-rate university, and every few years, the young instructor should take an additional course or several courses. These broaden his interests, give him fresh material, a larger background." This departmental head rejects, however, the opinion that knowledge of engineering as such is necessary or even desirable. In fact he says, "I should shy away from it; that is, if it means that the instructor has specialized in engineering. That is just what we must avoid. A general knowledge of . . . what engineering means, of its methods, and some of its principal problems—yes, of course this is desirable, and even essential, as one goes on."

Still another departmental head is so distrustful of the graduate schools that, when looking for instructors, he has frequently engaged promising young men who have just been graduated from colleges of liberal arts. One disadvantage of this method is that it may leave the instructor tied to his engineering college, blocking advancement. But a number of heads of departments feel that training as far as the master's degree is ample. One writes that his institution "has long felt that the possession of a doctor's degree was not necessary for effective teaching. That is particularly true in the field of English. . . . I think it well to urge instructors to secure the master's degree. Beyond that, experience in journalism or business will in my judgment prove more helpful than research for a doctorate." Another head writes: "I am convinced that a prospective teacher in an engineering school should have a thorough course in English through the M.A. But I think the Ph.D. grind in early English and related material is a sheer waste of time. Of course, I have no objection to the Ph.D. as a degree, but it does not qualify a man to teach engineers. I feel that after the M.A. the prospective teacher should have additional work in public speaking, journalism, the history of science, logic, art, and music, and bibliography."

On the other hand, a well-known teacher of English who has become an administrator believes that the graduate training to the

doctorate is desirable: "In the light of my experience, both as a teacher and an administrator, I am convinced that graduate training in English is almost essential to success. When instructors with such a background have failed, they have failed not because of its character but because they would have failed under any circumstances."

Instructors should be trained to teach composition. Training in composition is recognized as of the greatest importance. As expressed by one department head, "Two qualifications should be required of an instructor in English for engineering students: the first is that he should have as thorough training in composition as in literature; and the second is that he should have sense enough to motivate his courses so as to gain the interest of his students." This writer feels that the way to insure better instructors in the college of engineering is not to have its instructors in English trained in engineering, in science, or in journalism, but instead to have them properly trained in English. He points out that "English for engineering students is essentially the same as English for any other students, particularly . . . in the elementary courses. If any specialization is needed, it is in some advanced composition courses that make special applications of English in the writing of technical articles or reports; but these special courses are not in themselves so important as they seem, and any intelligent instructor can easily make the application."

The complaint that the graduate schools fail to train teachers of composition is perhaps the one most often and most vigorously expressed. This complaint is not, in general, that there are no teacher-training courses, although such courses are occasionally recommended. It is rather that the students do not obtain the fundamental knowledge of language that they will need when they become teachers. One head of a department writes that "we might well call on the graduate schools to see that their English men know much more than they do about contemporary English—about its rich and flexible grammatical system, about our inconveniently rich English vocabulary, about the levels of good English, about rational principles of usage, about our English consonants, vowels, and diphthongs, and about the interesting and important phenomena known as word accent and sentence stress. Too many college teachers of English are so ignorant of phonetics and so little acquainted with the great authorities of the English language that they cannot answer intelligently the questions about grammar and pronunciation that may come up in any freshman section at any time. A teacher who has spent valuable hours on the phonology and grammar of Old English may yet turn out to be ignorant of the three regional types of American pronunciation, of the difference between

a diphthong and a simple vowel, or of the difference between a weak form and a strong form of a word that he uses a hundrd times a day. An English teacher who does not know the great grammarians such as Curme and Jespersen is a prey to the mistaken dicta of the little grammarians."*

The instructors in English who have written the Committee, most of them younger men, repeat these criticisms of graduate training. Graduate instruction in English, they say, fails to prepare the student to teach any work in composition. They propose that the prospective teachers have in their training "more practice in composition and criticism than they have, without having any less emphasis on literary history." "The Ph.D. training, and graduate training in general," writes one instructor, "ignores the fact that most of the products are going out to teach, not in the graduate schools of the country, but in the undergraduate schools and in the grade and high schools. Some graduate courses cannot help benefiting . . . teachers of courses in literature . . . , but there is scarcely a graduate course offered which will aid the teacher of composition. Curious, is it not, when every M.A. and Ph.D. is going to do considerable composition teaching before he arrives in the 'green pastures' marked 'literature only,' and when, according to our guess, at least 50 per cent of the English sections in colleges and 50 per cent of college teaching are in composition. . . . Surely somewhere along the way [the instructor] should get some training in the teaching of composition: in methods of theme-reading; in methods of presenting, interestingly if possible, rules and regulations concerning grammar and punctuation and in any other kind of composition teaching he may be called upon to do; short-story writing, essay-writing, argument, exposition, magazine-article writing, report writing, journalism, and so on. In such a program, an extended study of linguistics, history of language, etc., might profitably be included."

The statement by the instructor just quoted that the graduate student has almost no teaching in composition is probably too emphatic. The writing of a thesis itself, if properly directed, is an excellent training in composition. And in the graduate schools there are a few courses in style, in modern usage, and in specialized composition that should directly aid a prospective teacher. On the other hand, it is exceedingly difficult to learn whether or not a candidate for an English instructorship is fitted for teaching com-

* From a paper read before the Conference on English at the annual meeting of the Society for the Promotion of Engineering Education, College Station, Texas, 1938, by Professor George Summey, Jr. In this paper Dr. Summey also states emphatically that many teachers of English "cannot practice with decent skill the art they profess to teach."

position, since recommendations from graduate schools are curiously uninforming in this respect. The assumption seems to be that a capable student of literature is sufficiently well prepared to teach composition. It is often difficult to learn whether or not a candidate for a position can write with reasonable skill and accuracy, although altogether too many letters of application at once reveal deficiencies or at least show a kind of carelessness that a composition teacher of merit is not likely to manifest. Recently graduate schools have been sending to heads of departments the names of their graduate students who are candidates for college positions with a brief statement regarding each student. Seldom is there reference to the candidate's skill in composition or to his probable ability to teach it.

Some graduate schools are made up largely of assistants who are spending part of their time in teaching freshman composition, and this teaching, which is usually directed by one of the mature members of the staff, is often called an apprenticeship. In some institutions there are occasional staff conferences, or there may be visitation of classes either for the purpose of evaluating the teaching or of giving suggestions for its improvement. That such training—if it can be called that—has some value cannot be denied. That it has proved to be a satisfactory training cannot be claimed. At least one engineering college hesitates to select instructors who have had this training. When the student's interests are divided between teaching and graduate work, the teaching is too likely to suffer, since the success of the teacher-student is primarily dependent upon his success as a student. Often students have gained a contemptuous attitude toward their teaching that continues after they have their degrees and are teaching in other institutions. One engineering dean, well known for his interest in English teaching, writes that the practice of using graduate students as classroom teachers "can not be condemned too often or too strongly."

Conclusions

In all this confusion of opinion about the kind of teacher wanted and the sort of experience or training that will help to produce the right kind of teacher, recommendations that will commend universal assent are of course not possible. But certain suggestions would seem to have the approval of a working majority.

1. The personality, character, and general cultivation of the instructor are of primary importance. All sorts of persons with all sorts of training have succeeded admirably in teaching engineering students. Intelligence, alertness, sympathy, good manners, courtesy, industry, command of one's field, and wide knowledge will

make one a good teacher whether or not he can talk intelligently about a power plant or has a command of physics.

2. It is desirable to enlist in the ranks of teachers of English a very small number of persons who have some knowledge of engineering or who have had practical experience in journalism or perhaps business. These men should also be well trained in English, although the Ph.D. may not be necessary for all. At least it should be possible for superior men to advance without the Ph.D. But it is neither necessary nor desirable that all or even a very large number of teachers should have had this engineering training or practical experience.

3. To succeed, however, in the present educational system the teachers of English should have a training that will command respect not only in engineering colleges but elsewhere. It is very doubtful if the engineering colleges alone can insure a future for many teachers of English. Often the teacher finds it necessary to transfer to the liberal arts college, and he should be able to do so. There is no reason, in fact, why the good teacher of engineering students should not be just as good when teaching students of commerce or agriculture or liberal arts.* Consequently, it is to be expected that many of our teachers will proceed as far as the doctor's degree if only to protect their own future.

4. There is no one set of requirements for a complete graduate education—that is, an education as far as the doctorate—that will be suitable for all, whether they are to teach in engineering colleges or not. But it is pretty obvious that certain training is likely to be helpful to the teacher of engineers:

(*a*) Probably most important at present is training that would equip the teacher of composition. Just what such training should be cannot be stated in this chapter. But the kind of training in language that is encouraged at the University of Michigan might well be stressed. Professor Marckwardt of that institution has made an excellent defense of language training in the course of which he remarks, "A Renaissance specialist, whether he likes it or not, will undoubtedly begin his professional career by teaching from one to three classes of Freshman composition. His chief efforts will be expended in attempting to establish the 'decencies' in the written and spoken language of his charges. In so doing, he will undoubtedly have to use textbooks which contain some truths about the English language, many more half-truths, and a good deal of palpable nonsense. To sift the truths from the nonsense requires

* Although this report is limited to instruction in English in engineering colleges, it should be emphasized that most of the unfavorable criticism and many of the suggestions for improvement are applicable to the teaching of all kinds of undergraduate students, including those in colleges of liberal arts.

a knowledge of the facts of present-day English and its development." †

A member of the Committee on English has also suggested that one part of the training should be teaching technical students under the supervision of a superior person who has proved his success. Certainly instruction in style and methods of analyzing writing should be included, for most beginning teachers of composition are quite ignorant of how to train students to improve their writing beyond the mere correction of mechanical errors.

(*b*) Prospective teachers should be well acquainted with the history of science, the history of art and music, the literature of the world, the history of philosophy, and trends in contemporary thought. A person with this broad training would command a respect from engineering students and teachers that the modern specialist is too likely not to have.

(*c*) Some ability to practice the art of composition should be manifested, as in the writing of a thesis, a critical work, or perhaps some creative work.

(*d*) Some believe that an acquaintance with physics or some phase of engineering would be desirable, and a few prospective teachers with the necessary aptitude might be encouraged in studies of this sort.

But it will be of little value to mention desirable qualities in teachers unless some concerted effort is made to produce teachers with these qualities. The following is suggested as one possible method:

(1) Select persons, perhaps persons who have just graduated from college, who have promise of becoming successful teachers of English in technical colleges. Some of them might be graduates of engineering colleges. Most of them evidently would not be. Some of them might be young teachers of English in the engineering colleges who have begun to show their worth.

(2) Outline with them a course of training that will be equal in difficulty to any other course, and, it is hoped, superior in value, with a view to making teachers of composition and teachers of literature for undergraduates. The plan should not be too rigid, for allowance must be made for the differences in individuals.

(3) See that scholarships or fellowships are made available for the training of these men, if necessary fellowships for more than one year, so that they need not delay their graduate work until they are middle-aged.

(4) Encourage students to go to graduate schools that are willing to coöperate in producing the kind of men desired. Perhaps

† Albert H. Marckwardt, "Language Study in the Graduate English Curriculum," *English Journal*, XXVII (1938), 570–576.

it will be possible to use graduate schools where there is an engineering college or where there are neighboring colleges of engineering with staffs of English professors that can coöperate in the practical training.

(5) See that these men, when trained, are given an opportunity to use their abilities and are advanced as rapidly as their own growth justifies.

A somewhat less ambitious plan but one which has great possibilities is to establish a summer school for teachers of English in the engineering college. It has been suggested that such a summer school be held in an institution that can supply enough engineering students for practical demonstrations and a few of the most successful teachers of engineering students of the country be invited to direct the studies of the group. Perhaps some institutions would be willing to pay the cost of sending representatives for a period of six weeks or longer. Perhaps a few scholarships could be established. The work would be very practical and would include methods of teaching composition and literature and perhaps speech. There should be plenty of time for discussions as well as for lectures and demonstrations. If an institution with a good summer climate were selected, it should not be difficult to bring together from all parts of the country a small and enthusiastic group of persons who are vitally interested in making English a more significant part of engineering education.

To accomplish what is here suggested would require the cooperative effort of a considerable number of engineering colleges. It would require some money. But the results should more than repay the cost.

VI

ORGANIZATION AND CONDITIONS *

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This study of the types of organization and conditions affecting the teaching of English to engineering students is based not only upon the hundreds of letters written to the Committee on English, but also upon the following surveys: the number of hours of *required* courses in composition, literature, and public speaking; the percentage of teachers in each rank teaching engineering students; and the type of organization by which English is taught.

Since experience and the consensus of opinion seem to indicate that the chief difficulties in all aspects of teaching English to engineering students are in universities with arts colleges, this type of engineering college was singled out for special study of organization and conditions—particularly those conditions involved in the kind of organization. In both independent technical schools and schools of mines, where all English is taught by one department and the instruction is planned for a homogeneous group of students, there should be no special problem in organizing the staff properly, in planning the kind of course that the college wants (though it might not be the most suitable), or in choosing properly qualified instructors. In colleges and universities that do not grant an A.B. degree, such as colleges of agriculture and mechanic arts (referred to hereafter as land-grant colleges), there is but little more of a problem. Here, too, only one department teaches all courses in English, and the students—though not all of them take only engineering or mining—are homogeneous for purposes of instruction, because all are primarily interested in science and presumably have the same vocational objectives. But in the engineering college that is grouped with an arts college in a university granting an A.B. degree (referred to hereafter as an A.B. university), there are all the troublesome problems of organization,

* Generous and valuable assistance has been given by the following teachers of English: Professor W. F. Scamman, University of Maine, who helped to plan the chapter; and Professor Alfred Westfall, Colorado State College of Agriculture and Mechanic Arts, Professor H. R. Young, Case School of Applied Science, and Professor Paul V. Thompson, College of Engineering, University of Colorado, who gathered the information about required courses.

type of course, and qualifications of instructor. Because of this condition and because colleges of engineering in this classification are more numerous than those in any other—there being nearly three times as many of them as of institutes and land-grant colleges combined—they were especially studied. To get most of the needed information, a questionnaire was sent to seventy-three deans of colleges of engineering within the classification. Of this number sixty-nine were returned. Since most of this questionnaire is not needed to understand the report, no part is reproduced here except the section that describes the kinds of organization, which is given later.

To avoid misunderstanding, it should be pointed out that the special studies were not made as ends in themselves, but as a means of providing a factual basis for the analysis and discussion of the subject of this part of the survey, namely, the organization by which English is taught and the conditions that may promote or hamper good teaching. For example, the concern here is not with the exact number of hours required in composition, literature, and public speaking by any one school, but with the typical or the general trend, because this might reveal a condition that stands in the way of good results in teaching.

To achieve the major objective of this chapter, answers have been sought to the following questions, the discussion of which constitutes the body of this section:

1. What kinds of organization are used for teaching English to engineering students?
2. How important is the kind of organization?
3. What factors limit results in teaching English?
4. What conditions stand in the way of getting and holding good teachers?

Kinds of Organization

In this study, the kind of organization is determined by the degree to which engineering students are segregated and the degree to which their instructors teach only engineering students. With slight modification here and there, six kinds are used, as described in the questionnaire.* The kinds of organization, it should be

* These kinds are:

1. Department is wholly within the College of Engineering, independent of the general or Arts College department.
2. An autonomous staff, nominally a part of the general or Arts College staff, teaches engineering students only.
3. Sections especially provided for engineering students are taught by instructors from the general or the Arts College staff who are deliberately assigned to these sections and who teach engineering students only.

noted, range from no segregation whatsoever to complete segregation of both students and instructors into a separate department within the college of engineering. Between these are important variations in the method of segregating, but they are so slight that they may be overlooked. This apparent similarity occurs in Nos. 3, 4, and 5, which should therefore be read carefully.

Based on segregation, the kind of organization is not of equal concern to all types of engineering schools. The independent technical institutes, of course, need not consider it; and the land-grant colleges seldom mention even a desire that a special kind of organization be provided for engineering students. The engineering colleges within A.B. universities, however, are so much concerned that they have devised all of the different arrangements described in the preceding paragraph. To these colleges the kind of organization seems important in teaching all aspects of English, but particularly the freshman course, which deals chiefly with usage and composition. The reason for this restriction probably is that nearly all schools (66 of the 69 that returned the questionnaire) require freshman English and that those requiring specialized writing courses in the upper classes can more easily find good instructors for them than for the freshman course.

The number of schools in this last group using each type of organization is as follows:

TABLE 1

No. 1.....	5	No. 4.....	13
No. 2.....	4	No. 5.....	5
No. 3.....	10	No. 6.....	29

The obvious conclusion derived from this table is that the prevalent type of organization is that in which engineering students are

a. Instructors are members of the engineering faculty.
x. They plan their courses with the wishes of this faculty in mind.
y. They plan their courses according to the wishes of the general department.
b. Instructors are *not* members of the engineering faculty.
x. They plan their courses, however, with the wishes of the engineering faculty in mind.
y. They plan their courses according to the wishes of the general department.

4. Sections especially provided for engineering students are taught by instructors from the general or Arts College staff who are deliberately assigned to these sections, but teach other students also.

5. Sections especially provided for engineering students are taught by instructors from the general Arts College staff who are not assigned. (Sections are given to any instructor who is available.)

6. No method of segregating students is provided. (Engineering students take the course in English provided for other students in the University.)

placed indiscriminately with all other students and are taught by members of the university department of English; but if all methods of segregating students are grouped, a large majority of schools (37 as opposed to 29) make some effort to segregate. Most of these thirty-seven, however, utilize instructors from the university departments, and not all of these instructors give their whole time to teaching engineering students; but nineteen have separate staffs teaching only engineering students.

An analysis of the questionnaire, together with a cross reference to the letters, shows that segregation of both staff and students is more complete than indicated by the table. Though only five colleges have their own independent departments, the four using No. 2 have the equivalent, because the instructors are only nominally members of the English staff in the arts college. Once assigned to the college of engineering, they are similar to a department in that college, with a chairman or head of staff, and they are responsible only to that college in planning courses and determining policy. These four, then, might be added to the five, making a total of nine colleges with their own departments. To this group might also be added two from No. 3, inasmuch as answers to questions 3*a* and *b* (see footnote, p. 67) state that members of these staffs belong to the engineering faculty and plan their courses according to the wishes of this faculty. They seem, therefore, to have enough autonomy to be classed under No. 2.

Further study of colleges using No. 4, moreover, shows that this classification might be misleading, because the large number suggests that many engineering schools do not want instructors to teach their students only; however, it often means merely that an instructor belonging to a specially chosen staff does not have enough engineering students to provide a full teaching schedule, and so he is given a section of other students. Since the colleges in this administrative predicament are trying earnestly to provide special staffs, they should also be added to those with segregated staffs and students. Evidence indicates that there are at least three of these colleges, which make a total of twenty-two with special staffs to teach engineering students. Of all the A.B. universities reporting the type of organization, this number is one-third.

Importance of Kind of Organization

The value of one type of organization over another may be best determined by analyzing the information given on the questionnaire by deans in the A.B. universities. In answer to a query as to whether or not they are satisfied with their present type of organization most deans said that they are. Only eleven expressed

any dissatisfaction, and most of these were not convinced that a change would insure better results in teaching. Only two were positive that a change was needed and that it would be beneficial. The kind of organization, however, that these eleven deans prefer, in place of the present kind—as given in the following table—suggests that the trend is still toward complete segregation:

TABLE 2

Present	Preferred	Present	Preferred
2*	1	6	1 or 2
2*	1	6	2
4	2	6	3
5	3	6	3
5	4	6	3 and 4 (combination)
		6	4

* These deans were not dissatisfied with results secured by No. 2, but thought that No. 1 would provide still better results.

Especially noteworthy, of course, is that each preference is for more segregation; that most of those preferring a change are now using No. 6; and that no one of these eleven wants No. 6. Moreover, this preference on the part of six colleges for some degree of segregation and of five for more segregation, when added to the thirty-two others that have segregation, suggests that a large number of colleges consider this kind of organization important.

Light from another angle on the importance of organization comes from fifty-nine answers to the following question: "Are your students taught English as well as you can reasonably expect them to be taught—as well, for example, as they are taught engineering subjects?" Only eleven deans said "No"—and these were not identically the same eleven, mentioned in the preceding paragraph, who preferred a different type of organization. This is less than a fifth of the total; yet the distribution, as shown in the following table may barely hint that the more complete the segregation, the less complaint about the results of the teaching:

TABLE 3

Plan No.	Number Satisfied	Number Dissatisfied	Per Cent Dissatisfied
1	5 all of colleges using this plan	0	0
2	4 all of colleges using this plan	0	0
3	6	3	33
4	9	3	25
5	3	1	25
6	21	4	20

Against this record of thirty-seven colleges in A.B. universities that utilize segregation to some degree, there are twenty-nine that do not. These, of course, are using No. 6. Subtracting from this number the six favoring segregation still leaves twenty-three, or slightly more than a third of the sixty-six reporting the type of organization. Some of these colleges apparently continue with No. 6 because it is the conventional procedure in teaching English, which they accept through inertia; but many are positively opposed to segregation and have accepted or provided No. 6 deliberately.

Both presidents and deans of these schools have expressed themselves on this subject. In summary they oppose segregation chiefly because it is expensive to administer; because they do not believe in specialized courses in English for their students, especially in the freshman year—the so-called "engineering English"; because they think their students should not be deprived of the intellectual stimulation and broadening influence that might come from mingling with students of varied interests; and because they assume that the segregation of students in one college means segregation of those in every other college.

Exemplifying the foregoing point of view is the following statement by the president of an Eastern university, who says, ". . . it would be a mistake to give instruction in English from a narrow engineering standpoint, and to confine it to what is 'practical.' For the engineer needs a broad training and a sympathetic feeling for many fields other than his own." And a dean who has had years of experience as practicing engineer, teacher, and administrator, writes as follows from a large state college in the Northwest: "[This college] has never adopted the plan that English must be different for engineers and for others. . . . We believe it would be a mistake to require special courses throughout for engineers. These courses are one of their few contacts with courses outside their own special field, and we believe this broader outlook has as much value to them as anything that could be included in special courses."

Obviously, it is not the purpose of this report to advocate or defend any kind of organization or method; but some of the objections to segregation reveal a few common misconceptions that should be examined. These are that segregation necessarily implies vocational courses for engineering students, that the term "Engineering English" or "Department of Engineering English" must mean a peculiar kind of English, and that the logical result of segregating engineering students would be the segregation of students of every college or division of the university.

Since the purpose of segregation is to give engineering students a program to fit their needs, some colleges do make their courses strictly vocational by limiting them to instruction in writing letters, reports, and technical papers; but most colleges believe that engineering students—in common with nearly all other students, including a large majority of those in the arts colleges who are not majoring in English—need a special course only insofar as it aims, not so much at literary refinement, with emphasis upon description and narration, as at the writing of clear, orderly, and forceful exposition. These colleges see, moreover, that segregation helps so much to motivate the work that, instead of being a narrowing influence, it gives opportunity for making the course broader and richer than would otherwise be possible. Merely because the engineering students are in their own classes, they feel that the course is especially designed for them; and so a skilful teacher should be able to give them as broad, cultural, and literary a course as he chooses—even the kind they would resent in the mixed sections of an arts college.

Criticism of the term "Engineering English" derives also from an objection to vocational courses. Though some engineers and even a few teachers of English seem to like its professional flavor, the term is to most people an unfortunate misnomer, because it tends to bring all courses designed for engineers into bad repute as something specious. This result is unfair, because most colleges with segregated students attach no significance to the name. Officially, they call their courses "English for Engineers," but this term is soon shortened to "Engineering English," just as "Department of English in the College of Engineering" becomes "Department of Engineering English" or "Engineering English Department."

Furthermore, the common assumption that segregation of engineering students would logically require the grouping of students in every other college or division of the university is valid only if segregation is based narrowly upon the specific professional or vocational interests of the students. Since its purpose, however, is merely to provide an opportunity for the kind of course needed by a majority of students, as explained previously, it need not lead to any such specialized brands as engineering, agricultural, or home economics English. A clear understanding of this point, and of the two preceding, is necessary if the merits of segregation are to be fairly assessed.

A study of all available evidence on the kinds of organization leads to no positive conclusion about the superiority of one type over another. It shows, of course, that a majority of the schools

prefer a kind that segregates their students, and that a large number want one that segregates both students and faculty. Furthermore, it indicates a slight tendency toward segregation or toward more complete segregation, but none away from it. On the whole, however, it seems to show that most colleges are satisfied with whatever type of organization they now have. The deduction to be made from this situation, perhaps, is that the best type is the one that most nearly fits local conditions. If the general university department of English provides a suitable course and teachers who know how to handle young men and motivate their instruction, segregation ought not to be necessary; but where these conditions are impossible, a college may need some degree of segregation—perhaps, even, an independent department.

Factors That Limit Results in Teaching

The chief difficulty in the way of finding the factors that limit results is that there is no general agreement—among administrators, teachers of English, or practicing engineers—as to what constitutes satisfactory results *in teaching English to engineering students.* The letters collected by the Committee show clearly the divergent opinions, which need not be quoted here because they are given in Chapters II and III. Obviously, until most of those concerned have decided upon their objectives, they cannot know whether or not they have achieved them.

In addition, the president and the dean of the same college sometimes evaluate results differently. For example, the president of a state university in the Northwest, where English is taught by the arts staff, says positively, "The work in composition and speech at [this University] has been singularly effective. Although the courses are given in the college of letters and science, we have a young man teaching English to engineering and other technical students who has handled the work extremely competently. The engineering students enjoy his courses and feel that they get a good deal out of them." But the dean says in part, "Usually the work is not so effective as desired. The main failure seems to be that of motivation." Similarly, the president of one of the large independent technical institutes writes confidently, "I believe the work in composition, literature, and speech at our own institution has been unusually effective." Yet the dean, with less confidence, says, "The work has probably not been so well done in the past as might be desired."

Because of their closeness to the problem, the deans might be expected to know more about it than the presidents, and so their dissatisfaction, freely expressed in their letters, should carry some

weight; but when fifty-nine of them in A.B. universities, whence come most complaints, answered only "yes" or "no" to the question "Are your students taught English as well as you can reasonably expect them to be taught—as well, for example, as they are taught engineering subjects?", forty-eight said "yes." Probably this large number means that the question is too restricted, but it seems to be fair in expecting no more of teachers of English than of others. In the face of all complaints, however, this number might mean that the deans believe their students are "taught English as well as you can reasonably expect them to be taught" until basic conditions are changed.

What are these conditions? Those most frequently mentioned as standing in the way of satisfactory results are (1) that students are inadequately prepared for college work; (2) that engineering students are indifferent or antagonistic to instruction in English; (3) that instructors are not sympathetic with engineering students and so make little effort to understand their special problems; (4) that courses are not suitably adapted to the needs of engineering students; (5) that members of the engineering staff are indifferent or antagonistic to courses in English; and (6) that both teachers of English and engineering students carry too heavy a load. These several reasons will be discussed in order.

(1) Though many deans and teachers of English complain that most of their students come from high school inadequately prepared, this situation need not be discussed here inasmuch as it is dealt with adequately in Chapter II. Here, however, it must be referred to emphatically because any effort to evaluate the teaching of English must take it into account. Yet it should not be used as an excuse. Though it adds difficulty to the job, some means must be found to improve results in spite of it.

(2) A more common criticism is that engineering students are indifferent and often antagonistic to instruction in English; and this criticism is also more pertinent, because the college should be able to do something about it. A thoughtful statement of this situation is presented by a dean in an A.B. university,—a man with years of active interest in the teaching of English—who says, "It is my belief that, if the engineering students do not get as much out of their English courses as they do from their engineering courses, it is not the fault of the English teachers, but is the engineering students' own fault. I do my best to impress my entering freshmen during Freshman Week with the importance of English, but 90 per cent of them come to the University with a fixed dislike of the subject. Few of them work hard enough to get much better than a passing grade and many fail. Those students

who have some appreciation of the importance of English and really work diligently to master the subject are given fine training."

Strangely, of the many teachers of English (not heads of departments) writing on this topic, only a few mention any resistance on the part of the students, and these few seem to show a petulance that indicates an injudicial temperament, as in the following excerpt from an instructor in a land-grant college: "My experience is that teaching engineering students is a thankless task." In contrast to this is a typical comment from an instructor in the same type of college: "Having taught two years in an engineering school —after four years of teaching in a liberal arts college for comparison,—I find no great difference in the two types of students." Many others have written similarly favorable comments; but nearly all of them, it should be noted, are teaching in technical institutes or land-grant colleges. This fact may mean that students in these schools are better conditioned for English or that the teachers, because of temperament or training, have adjusted themselves to their special jobs. From all types of schools, however, there is enough complaint to justify an assumption that the students' attitude is in many colleges a serious factor in limiting good results. But what causes this attitude and how can it be remedied? Neither deans nor teachers answer these questions directly, though many of them imply, at least, that the answers may be found in the conditions discussed under topics 3 and 4.

(3) The complaint coming most frequently from deans is that the teacher of English does not have the proper attitude. Some say that his training is not appropriate, but since the whole subject of the teacher's preparation is discussed in Chapter V, it need not be taken up here. In criticizing his attitude, the deans charge that the instructor is not sympathetic with engineering students and does not or will not understand their problems, as shown by the following comments extracted from letters: "In my opinion, the most effective way to improve the teaching of English in engineering colleges is to employ thoroughly competent teachers who are interested in engineering students and who understand the engineering students' attitude towards English." "On the part of the English teacher, improvement could be made if he took pains to acquaint himself with the work and ideals of the engineer and the engineering student." "More boys want to drop freshman English than almost any course in the University. I am afraid that the men with a Ph.D. in English are not very sympathetic with our engineering students. . . . Some of our men almost rebel against the work in English. I have had a number of students

. . . say they would rather take it by correspondence because of the fact that they just do not like to be in the class with the two men that are teaching the work. . . ."

Despite these numerous criticisms, many teachers of English have recognized the problem, and some feel that they have solved it satisfactorily, as expressed in the following excerpts from their letters, which have particular value because they point out some conditions that prevent a better relationship between teacher and student: "For myself, and I think for many of my colleagues, it is not true that we take no interest in a student. The truth may easily be, however, that he thinks of himself as an embryo engineer, and we are thinking of him (at best) as a potential human being, or (at least) an unwilling writer and reader of English. I have frequently found, however, that a friendly personal understanding will make palatable to students an otherwise unpleasant course, and will make him an interesting individual to his instructor. But since he is oversupplied with classes and laboratories, and we are oversupplied with students and paper-work, we generally fail to establish within our one-semester limit, such a friendly relationship." Another says, "Classes of an ordinary complexion largely composed of engineering students often include several assertive, contemptuous, narrow-minded, second-rate people who are bumptiously proud of their incapacity and philistinism. These need to be dealt with confidently and teasingly in the hope that some of them will see the light beyond their noses. They should be made aware that there are many in the world who regard their attitudes as small, immature, and ill-informed."

Some significance, perhaps, should be attached to the source of these and similar comments from both deans and teachers of English. Nearly all of the deans who complain about the teacher's attitude are in A.B. universities, and most of them are in those schools that have no segregation. None are in the institutions that have complete segregation of students and teachers. Only a few deans in land-grant colleges make this complaint; and none of the deans or presidents in the independent technical institutes. Moreover, nearly all teachers (not heads of departments) who wrote on this topic teach in land-grant or technical colleges. The obvious interpretation, then, is that teachers especially chosen to instruct engineering students or engineering and other students of similar interests are at least likely to handle their students with sympathetic understanding.

This conclusion, however, raises a serious question as to whether or not it is likely that many engineers overestimate the amount of motivation their students should have. Their many pleas for

understanding and sympathy lead one to believe that they do. They almost cause one to accept the description of an obviously irritated instructor who wrote about his difficulties in teaching engineering students, "I always feel that I am trying to cram an unpalatable something into a squeamish stomach." They give the impression that here are a lot of exceedingly delicate or spoiled children who do not like to drink their milk; but since drinking something with meals is good form, they may have sugar water if only they keep still. These conjectures—unfair, of course—are made plausible because only rarely does any administrator say a word about standards. He does not complain that results are unsatisfactory because the English teacher expects too little or lets too many students slip through with a bare passing grade; nor do many of them say that engineering students, being as bright as others and preparing to fill positions in society equally important, should be expected to pass creditably any course that other students are required to pass. Only a few deans, for example, write on this topic as positively as the following: "All engineering students are required to take in freshman year the same English course which is offered to academic freshmen; and engineering students are scattered through the various class sections and are treated exactly as academic students are treated. Engineering students are also subject to the same requirement which applies to academic students, that no student may be admitted to the junior class until he is reasonably proficient in the writing of correct and idiomatic English prose."

(4) Another complaint, made as often as the preceding, is that courses are not suitably adapted to the needs of engineering students. Yet, as pointed out earlier in this section, there is no general agreement as to what the students need. One dean—in an independent technical institute—says, "We view the English courses as cultural rather than professional, it being the aim of our curriculum to enrich the lives of the students through contact with literature instead of merely giving them the necessary rudiments of composition." But another dean—in an A.B. university—says, ". . . most English instructors insist that the student should take his examples from classical literature rather than from technical work. This arouses antagonism, or at least fails to arouse interest in the students." Still another—in a large land-grant college—seems to consider the course in composition and speech so vocational that he writes, "It may be found practical to have instruction given by engineers who have been successful and who realize its importance." Though there are exceptions, most deans who complain about courses share the opinions of the last two just

quoted. They think that engineers should have what some call a "functional" course—one that includes largely, if not solely, instruction in composition and speech, which is limited to the specific needs of engineers. According to most opinions, these needs are the ability to write letters and reports and to speak on technical subjects.

Others are more moderate, especially in their opinions of the kind of composition course that ought to be taught. Their concern is not so much with content as with emphasis and with motivation. In regard to the former, they think that since much of an engineer's writing must be expository, the course should treat chiefly of exposition, though they would not confine it to the explanation of technical subjects. Moreover, they think that engineering students, with little likelihood of writing primarily for aesthetic appeal, should be instructed mainly, though not solely, in the means of gaining clarity, accuracy, and a modicum of grace. Beyond this desire for proper emphasis is merely a plea for motivation, which depends mainly upon the instructor, involving his attitude toward the students, his assignment of theme subjects interesting to his students, and his use of illustrations drawn from technical work.

(5) Though many contend that the results in teaching English can be improved by making the student more receptive to instruction through a change in the teacher's attitude and through the proper adaptation of courses, a still larger number think that even more can be done by the engineering faculty. Both presidents and deans in all types of institutions—but chiefly those in the A.B. universities and, next in order, those in the land-grant colleges and the technical institutes—say that the members of the technical staffs must give the teachers of English more support than they do; and some charge that many of these instructors are as indifferent and antagonistic to the teaching of English as the students. This same criticism comes from a few teachers of English also, but not from as many as from administrators.

Because a president's detachment may give him a view of the educational ideals and objectives of the faculty clearer than that of a dean, the following three comments have particular weight. These, which are similar to many others, are from presidents representing in order each of the three types of schools: A.B. university, land-grant college, and technical institute: ". . . I do not think that the English Department alone can do much more than impart the fundamentals. It must have the coöperation of all other departments in the College. All must set up exacting standards and must insist that the students meet them. If a carelessly

written report is accepted as satisfactory, the students begin to feel that what they have been told in their English class is, after all, not so important." "In my opinion comparatively little of the responsibility for ineffectiveness rests with the departments of English and speech. Many of these departments have made extraordinary efforts to waken in the minds of engineering students effective appreciation of the importance of English. These efforts commonly are thwarted because forces stronger than the departments of English and speech operate in opposition. . . . The more I learn of the subject the more firmly I am convinced that the departments of English and speech are . . . fighting an uphill battle against bad English; and that the most important factor for improving the situation, as it relates to engineering, is the example and the attitude of the engineering faculties and of those who manage the engineering industries." "I think the improvements . . . will come most effectively from outside of the English Department. I would welcome the day when every instructor in class would insist upon the use of correct English in both written and oral work. I think each instructor should, as a matter of practice, call attention to the defects exhibited by students, and this should be done in the most effective way, whether in class or in private conference after class."

Fewer deans than presidents comment on this phase of the problem, but those who do are no less outspoken, as shown by the following clear analysis of the situation: "The Engineering College, however, feels that it cannot place the entire responsibility upon the English department. If a student presents a problem in applied mechanics or in electrical engineering in which an error in mathematics occurs, the instructor feels obliged to reduce the grade and in many cases he demands that the problem be reworked correctly. On the other hand, in the case of English he frequently passes mistakes without comment. Therefore, when the instructors in the College of Engineering feel that it is incumbent upon them to correct reports and problems upon the basis of the correctness of the language used as well as on the basis of the mathematical accuracy and engineering factual information the problem of improved English will solve itself."

Inasmuch as no deans state that the engineering faculties cooperate sufficiently, one might suspect that they are modest, because many teachers of English do, as did one who said frankly and positively, "From the School of Engineering we have always received most hearty coöperation." A number, however, are as critical as deans and presidents, as shown by the following remark from an instructor: "The complaint should not be that the in-

structor in English is not interested in the engineering student, but that the engineer is not conditioned to be interested in the English instructor." And the head of a department dismisses this whole survey as unnecessary with the conviction that "As a result of all the inquiries, you will, I venture to predict, come out with nothing that was not available in the findings of the admirable Wickenden report (c. 1925). We all knew then that engineers in industry were vociferous about the needs for training in English composition and speech." Then he goes on to say that we require no similar statements "to further weary us with this lip service. We need heads of engineering departments who are willing to give English and speech departments ample time for this work. . . ."

Because these unequivocal criticisms are made by only some of the administrators and teachers of English, though by a large number, an assumption may be that they come from institutions where conditions are not satisfactory. Certainly there are enough to suggest that the uncoöperative attitude of the engineering staff must account partly for the students' resistance, and must, consequently, stand in the way of effective teaching of English.

(6) Another barrier, mentioned less frequently, is the load carried by teachers of English and by students. Both administrators and teachers state that teachers have too many students and too many class hours, and consequently they are overburdened with the routine of meeting classes and grading papers. One dean, for example, gives this condition as the chief obstacle of effective teaching. "Our teaching," he says, "could be much improved if financial conditions were such that we could have more instructors and smaller sections. Many of our English Composition sections now have thirty and thirty-five students." A similar comment is made by an instructor, who points out also a serious consequence of overloading: "He [the teacher] realizes that any satisfying degree of success can come only when class instruction is supplemented with continued individual attention. The load of the average engineering English instructor makes this impossible. He can, perhaps, give occasional individual instruction to a few of his most needy students, but the few sparks he may strike only serve to deepen the general gloom."

Though other letters received from deans and teachers contain statements similar to the foregoing, they give no information that can be treated statistically. An attempt was made to get such evidence by means of the questionnaire, but, probably because of the phrasing of the questions, the answers were confusing, since a number of deans gave only the average number of students in a

section without giving the average number of sections for each instructor, and so the total average could not be computed. Moreover, some colleges without independent English staffs did not confine their report to those instructors teaching only engineering students. The figures, however, give some enlightenment. The hours range from 8 to 18, with 12 as typical; and the total average of students, where reported, ranges from 75 to 150. Of these latter, six colleges reported totals over 100, but probably others are also in this group, since only twelve colleges reported totals. No clear deduction can be made about these six either, though it is interesting to note that two of them, with 110 and 144, are among the five with independent departments, where the colleges of engineering are clearly responsible. Another college, with 110, utilizes plan No. 3 of segregation; two others utilize plan No. 4; and one, plan No. 6, or no segregation.

The total number of students for which an instructor is responsible is more important than the number of his class hours. This is especially true in teaching composition, which is an instructor's chief or sole duty in a college of engineering, because the bulk of the work consists in reading and evaluating themes. Since without this work, according to general belief, composition cannot be taught effectively, most arts colleges—and apparently colleges of engineering also—attempt to keep the total number of their students below a hundred. In general, the aim is to limit an instructor's load to twelve hours of classroom teaching (four sections, usually) and to about eighty students. This number, however, may be larger for instructors with some courses in literature, unless these also require numerous themes.

The student's load, mentioned occasionally as an obstacle to good results, refers to the amount of work in technical subjects. It does not mean here that the instructors in technical subjects include too many hours of their courses in the curriculum, but that they exact such a quantity of work that the student has no time left for any other subjects, whether they are officially in the curriculum or not. Since the student naturally considers his technical courses more valuable than others and must please these instructors, to whom he eventually will look for help in finding a job, he slights his English. This situation is expressed characteristically by the head of a department of English, who says in part, ". . . despite enthusiastic verbal endorsement by most of the influential members of the engineering staff, students continually find themselves under such heavy burdens of strictly technical work that they are indirectly encouraged to slight their work in English. Although this does not necessitate any lowering of our

standards in this Department, it does mean that a larger number of men do mediocre or grudging work, and thereby increase the difficulty of instruction in this subject."

Here is a condition so insidious that it probably is not mentioned by a larger number of critics only because they have not been conscious of it. Nor, perhaps, are the members of the technical staffs, though a teacher of English here and there believes that they crowd out English deliberately. Whether they are aware of it or not, everyone knows that they undoubtedly do apply pressure, just as do major professors in an arts college, who often take a disproportionate amount of their students' time, probably for the study of English; yet if colleges of engineering want to improve results in the teaching of English, they must curb this natural tendency.

Getting and Holding Good Teachers

The problem of getting and holding good teachers should logically be discussed as one of the factors that limit results, but it is important enough to be singled out for special emphasis. Inasmuch as both aspects of the problem come from similar conditions, the two can be discussed together. The first of these conditions is that many instructors think that teaching in an engineering college is a blind alley—and a rather gloomy one. The second is that no adequate means exists for bringing interested teacher and job together.

The principal complaints of instructors are that opportunities for advancement are slight; that the work itself is unattractive; and that those engaged in the work are likely to lose caste among other teachers of English. Though these charges are not made by all, and though they cannot be proved or denied, they come from so many teachers and may be so serious an impediment that they should be examined.

Are opportunities for advancement satisfactory? That is, can a competent instructor expect that in his own institution his promotion in rank and increase in salary will compare favorably with those of his colleagues; and if he is not satisfied in one college, can he reasonably expect to find a better position in the *same kind of work* elsewhere? Naturally these questions are relevant chiefly to those who are giving their whole time to engineering students or to engineering and others with professional and scientific interest—in technical institutes, in land-grant colleges, or in A.B. universities with completely segregated staffs.

The opportunities for teachers are always conjectural, based upon opinion. Presidents and deans seldom mention them, though

some say that the college must provide them, as does a dean in the following statement: "[There is a] general feeling among instructors of English that the teaching of composition to engineering students does not lead to advancement. I am sure in this connection that the administrative officials of engineering colleges must assume some responsibility. The teaching . . . must be made attractive to the right type of English instructor; that is, he must see a future in it." Another dean, however, whose college (in one of the largest state universities in the country) uses organization No. 3, praises the work of the English staff, but is ironically apathetic in doing anything to improve the status of its members. After explaining that English is taught by a separate staff with offices in an engineering building, but appointed by the University department, upon which it depends for rank and salary, he says, "This system has worked out satisfactorily. Professor [X] has a very satisfactory staff under him. There is, however, one serious criticism of the system that I would have, namely, that these men are not treated like full-fledged members of the English Department of the Arts College as to academic status. . . . Professor [X], the highest ranking man in the group, is an assistant professor; so you can see that none of them has advanced academically on a comparable basis with the Arts College staff. This situation may be corrected to some extent through the years, but undoubtedly these men will continue to operate under some handicap, which seems to me rather unfortunate. It is a matter that I have not yet had occasion to take up with the Arts College. . . ." And yet this dean, Professor X, and several of his instructors have been in this college at least a minimum of eight years! Incidentally, this situation reveals the weakness of plan No. 3, which leaves the members of the English staff dangling between the university English department and the college of Engineering, with no one actively concerned about their welfare.

Heads of departments of English, if they mention this topic at all, are generally vague, especially those in arts colleges who are responsible for segregated staffs or instructors assigned to teach engineering students. The frankest statements come from heads in the institutes or in colleges with independent departments. A characteristic statement is from a head of department in a large institute, who says, "There is some opportunity for promotion and advancement in salary for the man who devotes himself to teaching English to technical students. But less, I think most of us will agree, than for the man of science, or for teachers of English in arts colleges." This point of view is borne out by the head of an independent department in an A.B. university, who writes frankly of his own experience: "Up to this time there has been

some but not enough advancement to attract the better men who propose to teach English. I know that when I decided to teach in an engineering school rather than in a college, some of my beloved teachers were astonished and warned me not to throw away my time teaching technical students. The teachers sincerely believed that there was more future elsewhere." Probably they were right, because this man, warmly praised by his dean, has been teaching in the same college about ten years and is still an assistant professor at $2800. And no one is directly responsible for his status except the dean of the college of engineering! Apropos of this situation is the complaint of a dean that one barrier to good results is "the employment of immature English instructors, especially in composition." But if deans do not provide for their own staff any better than for this man and for Professor X, how can they hope to get and hold mature teachers?

Since opportunities open to young instructors may be revealed by the present situation, a study was made of the number of teachers, ranks, and salaries in the group of colleges about which least is definitely known, those in the A.B. universities. In all of the 66 schools reporting on this topic there are 692 teachers of English, distributed according to rank and plan of organization as shown in the following table. Under each rank is given in the first column the number and in the second column the percentage.

TABLE 4

Plan	Professors	Assoc. Profs.	Ass't. Profs.	Instructors	Assistants
No. 1	3— 9%	8*—25%	6—19%	9—28%	6—19%
No. 2	1— 4	2— 7	1— 4	9—33	14†—52
No. 3	4—10	2— 5	9—22	23—56	3— 7
No. 4	7—11	5— 8	18—30	29—48	2— 3
No. 5	10—26	4—10	8—21	17—43	——
No. 6	39— 8	39— 8	80—16	189—38	145—30
Total number and total average %	64— 9%	60— 9%	122—18%	276—40%	170—24%

* Six of these are in one college.
† Thirteen of these are in one college.

As an indication of opportunities based on existing jobs, the foregoing table is probably not accurate, because those colleges using plan No. 6 undoubtedly reported all members of the English staffs who would be likely to teach engineering students instead of only those actually teaching them. Obviously, they could scarcely do otherwise, inasmuch as engineers are not segregated. A similar

reservation may be necessary in considering the returns from colleges using plans No. 4 and 5, because, even though they segregate students, they do not always assign to them the same teachers.

Probably a fairer idea of possible opportunities could be gained from a tabulation of teachers in each rank within colleges that segregate both students and teachers, that is, colleges using plans No. 1, 2, and 3. These colleges report exactly one hundred teachers. To preserve anonymity, the colleges are designated by numbers and they are not arranged in any special order.

TABLE 5

	Professors	Assoc. Profs.	Ass't. Profs.	Instructors	Assistants
1	0	0	1	1	0
2	1	6	2	6	5
3	0	1	0	0	0
4	1	0	2	1	0
5	1	1	1	1	1
6	0	0	1	0	0
7	0	1	1	0	0
8	1	0	0	1	0
9	0	0	1	3	0
10	2	0	3	6	0
11	0	0	1	6	0
12	0	1	1	1	0
13	0	0	1	2	0
14	1	0	0	1	3
15	0	0	0	3	0
16	0	1	0	4	13
17	1	0	1	2	0
18	0	1	0	1	0
19	0	0	0	2	1
	8—8%	12—12%	16—16%	41—41%	23—23%

Conspicuously revealed by this table is that few teachers with only engineering students in an A.B. university need aspire to a full professorship. The opportunity is not even so great as shown here, because in each of two institutions the professor is merely in general charge, giving most of his time to the arts college. The total number of associate professors is here misleading because of the large number in one college. This means not merely that most of the teaching is done by assistant professors and instructors—chiefly instructors—but that the direction of the work also is given to those in the lower ranks. In seven of these schools there is no one above the rank of assistant professor; in two others there is no one above the rank of instructor; and in two others there is no

one between a single professor and the instructors. More important is the fact that in two of the five independent departments, where the deans of engineering are responsible, the head is not a professor. In one he is an associate professor, and in the other an assistant professor. Equally worthy of notice, however, is that there are not so many assistants as might be expected in A.B universities with graduate students to care for, provided the thirteen in one college are omitted.

Inasmuch as all of these colleges segregate both students and teachers, there is some fairness in comparing the totals and the average percentages with the totals and average percentages in the land-grant colleges; in the independent technical institutes, both of which teach the same kind of students; and in ten representative arts colleges. For this last group, the percentages may not be entirely accurate, because they are based upon figures taken from catalogs, which do not always list assistants.

TABLE 6

	Professors	Assoc. Profs.	Ass't. Profs.	Instructors	Assistants
A.B. universities No. 1, 2, and 3	8— 8%	12—12%	16—16%	41—41%	23—23%
Land-grant colleges	28—15%	30—16%	48—26%	70—38%	8— 5%
Institutes	12—15%	17—21%	22—27%	29—36%	1— 1%
Ten arts colleges	68—24%	36—13%	51—18%	100—35%	30—10%

Not much information could be secured about salaries because many schools, for one reason or another, did not give it. Some idea can be gained, however, from the following tabulation of average salaries for each rank paid in the schools listed in Table 5.

If these salaries are representative, then the whole scale is low. Only a few stand out as adequate, though others might also be considered very good in some localities. It is possible, of course, that all salaries are unusually low because of the depression, but this explanation does not seem valid for a large group. Even if it were, there are so few teachers in the upper ranks that not many young men can look forward to the higher salaries. It is true, of course, that in some of these universities the teachers may be assigned to the college of engineering only temporarily and go back to the arts college, where they are promoted; but this doubtful probability does not help those who want to make a career of teaching engineering students, nor does it provide for these students mature teachers.

Although teachers of English are concerned about rank and salary, they complain more frequently that the work is not attrac-

TABLE 7

	Professors	Assoc. Profs.	Ass't. Profs.	Instructors	Assistants
1	——	——	$2800	$ 600 (part time)	——
2	$5000	$2980	$2700	$1960	$1300
3	——	$3200	——	——	——
4	$3700	——	$2200	$1600	——
5	$4990	$2400	$2100	$1400	$1000
6	——	——	$2100	——	——
7	(Not reported)				
8	(Not reported)				
9	——	——	$2150	$1800	——
10	$3700	——	$2333	$1700	——
11	——	——	$3300	$1900	——
12	——	$2200	$1800	$1500	——
13	——	——	$3000	$2000	——
14	$5000	$4000	$3200	$2100	——
15	——	——	——	$2000	——
16	——	$3000	——	$1902	$ 685
17	$2850	——	$1985	$1500	——
18	——	$2850	——	$2100	——
19	——	——	——	$1200	——

tive. What they mean is that in nearly all colleges the courses are elementary; that most of these are in composition, with their heavy burden of paper work; that they can never have the stimulus that comes from teaching majors or graduate students; that the position is not accorded the dignity of importance by members of either the arts college or the engineering college; and that they have little time for the study, research, and publication that bring professional growth and advancement. Those in the land-grant colleges and the independent institutes have the added complaint that they miss the association with colleagues who are teaching advanced courses and that, even when they have time for study and research, the college libraries do not contain the books they need. Those in the institutes, however, seldom comment on the narrowness of their program, probably because it includes a high percentage of literature.

The following comments, by teachers representing both land-grant colleges and A.B. universities, are typical: "The average English instructor coming out of our graduate schools automatically steers away from specialized teaching in the engineering college. His training has not been in that direction; his tastes do not lead him that way, and his normal desires for advancement lie within the field of his specialty. . . . A man who has spent years of preparation to teach courses in American literature does not feel that there is much future for him if he must give the time to

teaching specialized courses for engineers." ". . . the English instructor's world exists quite outside his college [college of engineering]; sometimes he feels that he is a foreigner, even at times unwelcome. In his college, English signifies chiefly grammar and rhetoric and endless themes—most of them requiring no creative criticism, only a consumption of time. Too frequently his class teaching requires but a low degree of showmanship. It is true that the young instructor, wherever he go, must expect to perform these duties. But too often, for the teacher of engineers, they continue to be the staple work on into the higher ranks." "Because of the scarcity of advanced work and the rarity of well-prepared students who wish to know much about literature and to read much and widely, naturally the professor of English in a technical college is never going to use anything like his full capacities or knowledge. The long apprenticeship in most colleges makes the same thing true for some instructors for many years, and in some instances for life; but here we leave all hope of that sort behind. Besides, we are a 'service department,' in which only the head will receive a salary comparing with salaries paid to technical men of the same academic rank."

Since much of the dissatisfaction is with the type of course, which gives an instructor little opportunity to teach literature, a study was made of the number of hours in composition, in literature, and in speech *required* by colleges in A.B. universities, land-grant colleges, and technical institutes. No attempt was made to discover the number of hours elected, because accurate information is not available; moreover, there is much evidence that in schools where electives are offered, very few students take them. The following table gives the average of *semester* hours required in each type of institution:

TABLE 8

Freshman Year	Composition	Literature	Speech	Total of English
A.B. universities	5½	⅕	⅙	5¾
Land-grant colleges	4⅓	½	¼	5¼
Technical institutes	4⅛	1	⅛	5½
Upperclass Years				
A.B. universities	1¾	1	⅖	3½
Land-grant colleges	3	1	1⅛	5
Technical institutes	2⅛	2¾	1⅜	6½

Total of English for All Years

A.B. universities	9½
Land-grant colleges	10+
Technical institutes	12

The totals are interesting; but the instructor's complaint that teaching engineering students is unattractive is illuminated much more by the average hours of literature required in the engineering colleges, particularly as compared with those required in composition. Contrary to what the layman might expect, the independent institutes, serving only technical students, *require* more than twice as much literature as the other types of schools, a condition that might explain why teachers in these schools seem to be better satisfied than others. On the other hand, colleges in A.B. universities, the reputed abiding place of culture, *require* the least. This record is even worse when one considers that colleges using plans No. 1, 2, and 3, with both students and teachers segregated in independent departments or their equivalent, require next to no literature in the entire four-year curriculum, as shown in the following table:

TABLE 9

No. 1—(5 independent departments)	1 hr. (Average in all years.)
No. 2—(4 autonomous staffs)	0 hr. (Average in all years.)
No. 3—(10 segregated staffs and students)	⅕ hr.*(Average in all years.)

* Two hours at one college were not included because they were required by only a small minority of departments.

It must be remembered, of course, that electives are open to engineers in many of these schools. According to the meagre evidence, the number of students taking them is closely in proportion to the number of required hours, the largest number being in the institutes and the smallest in the A.B. universities. Apparently, however, this number is not large enough to change the record much.

Since most of the required courses in literature are elementary, the only conclusion that can be drawn from these figures is that any one who wants to give his professional life to teaching engineering students will have only a slight chance to do any work beyond the elementary, with a preponderance of it in composition. If this kind of work, then, does not attract first-class teachers of English, the colleges of engineering cannot expect to get them or hold them unless they are willing to enrich their curricula with more courses in literature.

This condition, more than any other, is responsible for a third common complaint of the teachers: that they lose caste with their colleagues in the arts colleges. Because they must teach elementary courses—elementary even among undergraduate courses—they are often looked upon as inferior. So, too, are those teaching composition in the arts colleges; but generally they are, at least, in the general department of English and may sometimes have a

chance to teach advanced courses. This chance the teachers of engineering students do not have. Moreover, they cannot get it by changing to the arts college, because, even if they are recognized as capable, they are usually thought to be rusty in the advanced courses and out of touch with the problems of the arts college department.

That this situation is true is believed by a man who has until recently given years to teaching engineering students in an A.B. university. He writes, "If the school is entirely a technical one, a successful instructor may undoubtedly look forward to slow but steady promotion. If he is successful as a writer or in the affairs of national learned societies, he may even look for calls from other institutions in the same field; but, as a very good friend of mine told me recently, to enter the profession of teaching English to technical students solely is equivalent to 'committing professional suicide,' so far as receiving calls from the better American institutions where English and American literature departments are stressed is concerned. One always has to consider the fact that an English department in a technical institution is always a service department and may never hope to encourage students to major in literature or writing. For this reason, I personally chose not to accept a position in such an institution, believing that it would lead into a blind alley." A similar opinion is held by the head of the English department in a large technical institute, where his record of service is long and well-known. In answer to an inquiry about the opportunities of a teacher of engineering students, he says, "If this means his opportunities in a school of technology, they are probably as good as those of the teacher of technology. That is, he will be advanced in rank and salary as far as the conditions in the department permit. If the question refers to his opportunities in a non-technical college, they are practically nil. 'Leave hope behind all ye who enter here' should be the motto over the door of the school of technology entered by an instructor in English. He will never be called to another kind of institution unless he has perchance made friends who have a 'pull' or has made a name for himself outside, quite apart from his work as teacher in his school of technology; unless, for instance, he has won distinction as a writer."

If this plight of the teacher is accurately described—if he is seldom able to transfer from the engineering college to the arts college, then an important, fundamental question is, "Do the colleges of engineering provide sufficient opportunities within themselves for professional advancement and personal satisfaction?" Based upon the evidence, the answer is decidedly "no."

Yet, in spite of these handicaps, there are competent persons

making a career of teaching engineering students—probably because they are in exceptional colleges with the broader opportunities—and some of these, now in lower ranks, might be available for better positions in other colleges, probably to take charge of the work. If these qualified teachers could move to other technical schools, their chances for advancement might be increased. In addition to these experienced teachers, there must be some promising young men willing to undertake this work. At present, however, there is no adequate means of bringing together the teacher and the job.

In the first place, many deans of engineering do not appoint their teachers of English, and often they have no voice in the selection. Obviously, this situation exists chiefly in the A.B. universities, but somewhat in the land-grant colleges. Information gathered on this topic by means of the questionnaire shows that 22 deans out of 43 are not consulted about appointments. What happens, then, is that they get instructors who are chosen to teach in the arts college and who promptly become dissatisfied.

But more serious, inasmuch as many deans in all types of colleges do participate in making appointments, is the fact that those administrators who want to select qualified teachers have only chance knowledge of available candidates from among either the experienced or the untried. It seems reasonable that better choices would be made if there were some central exchange which would have available the records of all instructors who are either teaching engineering students or want to. This might be set up by the Committee on English of the S. P. E. E., though, in order to keep it above suspicion, it should be directly in charge of a committee or a director with no desire for another position. Not only would this exchange improve instruction and give teachers an enlarged opportunity, but it would also help to prevent the present shameful waste of talent now on hand and available.

Conclusions

The more important conclusions to be drawn from this phase of the survey are as follows:

1. The plan of organization is not in itself essential to satisfactory results, which can be secured under any kind if the teachers are competent and other conditions are propitious. Most administrators in A.B. universities, however, prefer that their students be segregated, and many think that the teachers should be definitely chosen to teach only engineering students. The general tendency in these schools is toward segregation.

2. A special effort should be made in every institution to instill in the students a favorable attitude toward English.

3. The attitude of students can be shaped properly by sympathetic and understanding teachers, by courses adapted to the interest and needs of engineering students, and by the precept and example of the technical staff.

4. The teaching load of the instructor in English should be reduced, where necessary, to a maximum of 12 hours of class work and 80 students, especially for those teaching only composition.

5. The technical staff should allow their students time to do good work in the English courses on their schedule.

6. The ranks and salaries of teachers of English should be commensurate with those of the technical staff. In the A.B. universities this need is especially conspicuous. In many departments there should be more teachers in the higher ranks, particularly those at the head of the staff.

7. In addition to rank and salary, the teacher's work should be made more attractive by according it recognition as an integral and indispensable part of an engineering curriculum, and by providing in the English program more courses in literature than are now found in most curricula.

8. Some means should be devised for bringing together teacher and job. In the first place, deans in technical schools, especially in A.B. universities, should have more voice than they do in choosing the English staff; and in the second place, some kind of agency should be established to provide administrators with the records of both experienced and prospective teachers.

VII

UNUSUAL PLANS AND METHODS IN ENGLISH

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The investigations of the Committee on English have brought out several interesting departures from what might be called the normal procedure in teaching English in engineering schools. It is the province of this chapter to present some of these plans, partly as a record of the work being done, but chiefly as suggestions for schools that are able and willing to experiment a little.

Although previous studies by Professor A. M. Fountain * of the North Carolina State College and Professor W. O. Birk † of the University of Colorado have shown a great variety of course names and of subject matter taught by departments of English, it is probably quite accurate to list the following as the normal or usual courses, credit for which would be accepted by deans in transferring students and interpretation of which would be comparatively uniform.

English Composition (or Freshman English)
Theme Writing
Survey of English Literature
Technical Writing (sometimes more specifically):
    Business Letters
    Report Writing
American Literature
Contemporary Literature
Public Speaking

Courses with these names conform to the three-fold objective that has come to be applied to courses in English in most engineering colleges: (1) to give students practice and skill in writing clear and accurate English; (2) to acquaint students with what has been going on in the world through the best books in the English language in the fields of literature, biography, travel, science, and philosophy; and (3) to afford students some training in oral expres-

* Fountain, A. M. "A Study of Courses in Technical Writing," Raleigh, North Carolina (1938).

† Chapter VI of this Report.

sion. Modifications of the usual courses do not depart from these objectives, but strive in and through their differences to accomplish the same purposes.

Experimentation is probably easier in the institutions that have autonomous departments of English, for the mingling of liberal arts students with engineering students or of other professional groups with engineering classes complicates special adaptations of methods or material. Experimentation, also, depends upon the availability of personnel and time. Some courses that are different have originated with outstanding personalities; among the pioneers in the field were Professor S. C. Earle of Tufts College, Professor W. O. Sypherd of the University of Delaware, Professor H. A. Watt of the University of Wisconsin, Professor J. R. Nelson of the University of Michigan, and Professor J. M. Telleen of the Case School of Applied Science. Sometimes local conditions have given a kind of "set" to courses, and sometimes the historical background of an institution has started instruction along a certain line.

We are now ready to look at courses that have been unusual either in content, in classroom methods, or in their relation to actual engineering work. We shall try to inquire into the purposes back of the unusual courses, with the implication that they might be selected for trial by other schools. The discussion will relate to individual courses rather than to departments or to institutions as a unit.

I. Courses That Vary the Subject Matter from That of the Normal Type of Course

Not many colleges depart from the subject matter of Freshman Composition, usually given in the first semester and often throughout the first year. There is, however, considerable variation in the use of textbooks, some preferring a handbook, which is essentially a reference book, and others selecting a discussion of composition or the four types of writing, a book much like the older rhetorics. A few use a text that has many specimens that can be studied and analyzed. The use of practice leaves, loose-leaf notebooks for exercises, correction charts, etc., does not really constitute "unusualness," because they are all devices to make instruction in grammar, punctuation, and spelling as painless as possible and as interesting as may be to the students. The big problem is to give proper motivation to avoid monotony and drudgery.

For many years the Case School of Applied Science has used the subject matter of argumentation and debate as the chief material for the first term of the freshman year. An attempt has been made to give a course distinctly different from high school English

and to gain motivation by discussing current problems and by employing the fundamental method of analysis associated with engineering. Theme topics grow out of class debates, correctness of writing being checked against a standard handbook. This type of course also permits the faculty to offer supervised oral work early in the student's career.

The Massachusetts Institute of Technology includes special items with composition in the first term, such as preparation of patent specifications, description of a mechanical device, and the use of the library. Beginning with the second term, three parallel courses are open, one of which must be chosen. The three courses are Modern History, American Literature, and Scientific Thought. The same system of grouping is continued in the sophomore year, but changes from one group to another are allowed and even recommended, the theory being that the student will profit by acquaintance with at least two of the groups. As a matter of fact, the preferences are about evenly divided without faculty adjustment. Considerable written work in both long and short themes is required in each group, with, of course, a high standard in composition. Many of the staff are trained in history.

The usual course in literature is varied more frequently. The University of Virginia requires a study of great books through lectures and reading, the purpose being to present materpieces of world literature rather than to keep to the narrower field of English and American, and also to stimulate independent reading both in college and after graduation. The historical framework is much restricted, as compared with a survey course. The California Institute of Technology also has had success in stimulating non-credit reading, in their case through lists of books for summer reading, recognition for which is an extra-curricula credit. A course in Modern Literature is required at the University of Maine, and Rensselaer Polytechnic Institute has an elective in Comparative Literature. The Virginia Polytechnic Institute gives a course in Southern Literature, making an appeal to local pride as well as recognizing that the literature of the section from which many students come and in which many graduates will reside will have special value to the people of that region. Other sections of the country might well find similarly rich bodies of literature that could be used as course material.

Special forms of literature, such as the essay, the short story, the novel, or drama, are given definite place in many schools, probably on the theory that high schools give a survey course in literature and the college may well build more specialized courses on that foundation. Most schools give separate courses; a few combine two

or more into a Types of Literature course. The Case School of Applied Science has a separate course for the Essay, required in the second semester of the freshman year, and a Types course that includes drama, poetry, and the novel, in the sophomore year, also required. Only a very few separate courses in poetry are found. The Polytechnic Institute of Brooklyn and the Massachusetts Institute of Technology recognize the value of play production in teaching literary appreciation, for both offer valuable training in play writing, play production and direction, and acting. The Carnegie Institute of Technology also does a great deal in play production but it is not limited to the engineering students and for them would be an activity, as it is in many other institutions. Frequently elective courses in play reading and classroom discussion of plays appear.

Weakness in vocabulary is a point that has brought frequent criticism upon engineers, but hardly an institution mentions any course designed to correct this fault. Perhaps it can best be overcome by incidental drill in some course in literature; surely vocabulary study ought to find a place somewhere. The English faculty at the Case School of Applied Science emphasizes vocabulary study in the course on the Essay. Vocabulary tests are given in almost every session of the class, with repeated emphasis on the use of a dictionary. The California Institute of Technology has found that essays used in such a course should not be exclusively scientific. From the point of view both of vocabulary and of student interest, the essay should be general in subject and inclusive in period.

Under the general heading of Technical Writing, several schools vary the usual textbook and long-paper type of instruction by furnishing current technical periodicals or documents from actual files. Washington University, North Dakota Agricultural College, the University of Maine, and Montana State College use scientific or engineering periodicals; Case School of Applied Science uses one to supplement the textbook; Armour Institute of Technology, the University of Hawaii, the University of Maryland, the University of New Hampshire, and the South Dakota School of Mines secure fresh reports and letters to supplement textbook specimens. The Ohio State University has used a business man's approach through letters and reports to secure student interest.

Armour Institute of Technology introduces a course in logic in the sophomore year, which is made to tie in with scientific theory and writings. This approaches one of the parallel groups mentioned in the course at the Massachusetts Institute of Technology. There seems to be no reason why a department of English should not adopt the theory that writing and thinking as found in science can assist a student in developing a satisfactory style of his own.

At least two institutions combine literature and composion in the same course in interesting ways. The California Institute of Technology lists a course entitled "English Composition and Reading," in which essays and short stories are used as the basis for teaching composition. The United States Naval Academy and The Polytechnic Institute of Brooklyn also combine literature with some technical writing in one course. The time factor may lead to such a combination, and, of course, creative writing, whether technical or literary, can be closely related to specimens that are noted for their fine qualities of style.

Another type of course that is found replacing the more usual survey course is one that can be labeled History of Civilization. In many schools such a course is in addition to the normal English course and is taught by a separate department—history, social studies, or a combination of engineering staffs. Orientation courses or engineering background lectures are involved here, as well as a straight course in history. If such a course is taught by the department of English, an effort is made to teach style and correctness in the mechanics of composition through the papers required to accompany textbook or lectures. The Carnegie Institute of Technology has such a course under the department of English. Union College gives to its engineering students a course in Engineering Lectures covering the history of engineering, present day achievements in engineering, and the professional aspects of engineering.

As with the Massachusetts Institute of Technology, a few schools put courses in history on the required list. The Alabama Polytechnic Institute gives a course in the History and Government of the United States; the Carnegie Institute of Technology gives Civilization in the United States, with special reference to the period following the Civil War; and Armour Institute of Technology offers a course in Contemporary Problems. In some cases such courses are electives, or are electives under certain conditions of schedule; in several, however, they are the required work in English either first or second year.

Public Speaking varies chiefly in the amount of time allotted to it. Some schools have complete textbooks of theory, others use only a project book. The purpose in all is undoubtedly to give a maximum of supervised practice to the students.

II. Courses That Present Unusual Classroom Methods

There are a number of instances in which the usual order or sequence of courses is changed. Stevens Institute puts its course in literature in the freshman year and its course in composition in the sophomore year. In the first year at Yale University, literature

is required of all men and is continued in the second year. At the University of Rochester, literature is an elective for all except engineering students, but is required of them in the freshman year. Purdue University puts its Advanced Composition in the junior year.

Two variations in handling technical writing are found; in the University of Florida, a writing laboratory, with projects of the students' own choosing, is conducted, and in the University of Idaho, two long reports are made the center of instruction. The former arrangement is not limited to engineering students, and the latter is used to extend the personal contacts of the students with practicing engineers and available books in the field chosen.

A number of colleges have a systematic plan of individual conferences with students to see that classroom procedure is both understood and applied. This plan can be used with any course material. It is a means supplementing the desk or textbook instruction and often involves the comprehensive examination; in some non-engineering colleges it develops into the seminar or project program wherein the student's work is largely individual or supervised research. Conferences are not found in this extreme use in any engineering school, so far as noted. The University of Cincinnati, Cooper Union, Tufts College, and the Massachusetts Institute of Technology have all developed the conference plan in a thorough and consistent way as a requirement. The Carnegie Institute of Technology requires regular conferences with senior students over the written work prepared in the technical departments. Probably all teachers of English have occasional conferences as circumstances demand; these do not figure in teaching loads as such. The tendency is unquestionably to place more emphasis on conferences as a means of teaching, but the problems of time and teaching load complicate the matter.

Purdue University has been successful with the recall provision, whereby all written work in the junior and senior years is subject to perusal and criticism by a special Committee on English that may (and does) require additional instruction and work and even prevents graduation until satisfactory performance is reached. The remedial work given the student depends in amount and in difficulty on the nature of his trouble. The principle here involved is one that is sound pedagogically, the difficulties being those of schedule and teaching load. There is also a possible difficulty in winning the consistent coöperation of the members of the engineering staffs. It has a distinct advantage in being applied after students have passed the required English of the first two years and of reaching transfer students who have come after the required work has been credited to another institution. There are valuable points

in a plan like this, particularly if it can enlist, as it does at Purdue University, the active assistance of teachers outside the department of English.

Required courses in English are almost everywhere limited to the first two years; offerings beyond that period are electives. Almost every engineering school gives optional courses, sometimes bracketing cultural and non-cultural courses together, sometimes (and more soundly) requiring an election from a list of humanistic subjects. The aim, of course, is to extend the range of information of the student to non-engineering fields and to allow the development of individual interests and abilities. A few electives are admittedly "tool" courses, but much more frequently the electives do not contribute to engineering skill or professional efficiency. A great variety of elective courses has been noted, involving almost as great a variety of classroom methods. Probably a sound principle to follow is that an elective should not be offered unless there is a man on the faculty well qualified to teach it. An elective simply for the sake of an impressive list is bad psychology. Departments of English do not often contain men who can go outside the field of literature for offerings, but wherever there are men trained in history, social studies, journalism, psychology, or speech, such teachers should be allowed and encouraged to present their elective courses. The most extensive list of electives in any one institution, so far as discovered, is that at the Massachusetts Institute of Technology; but here, it must be remembered, history, scientific thought, and the fine arts are the normal assignments of the department of English. It may be well to give the list, to show what can be done, if personnel and teaching loads permit. For a few of the electives, faculty members of other departments are drawn upon, and that situation would be more definitely true in other engineering schools. The electives are grouped under four heads: History of Science and Thought, History of Civilization, Literature and Fine Arts, and Social Sciences; these are indicated by number in the list.

I. History of Science
History of Mathematics
Problems of Modern Philosophy
History of Philosophy
Biography in Science
Descriptive Astronomy

II. The United States and Latin America
History of Engineering
History of the Far East
The Social and Industrial History of Modern Europe
The Social and Industrial History of the United States

Military History and Policy of the United States
Development of Navigation and Cartography
Economic Geography

III. Advanced Composition
American Literature
Contemporary European Literature
Contemporary English Literature
French Literature
German Literature
German Fiction
Dante in English
Public Speaking
The Bible as Literature
Shakespeare
Literature and the Fine Arts
Design in Manufactured Products
History of Music
Introduction to Music

IV. Introductory Psychology
Study of Human Relations
Comparative Political Institutions
Comparative Economic Institutions
Introduction to International Relations
Principles of Sanitary Science and Public Health
Biological Reproduction

The University of Washington offers electives under the four headings: (1) The Physical Environment, (2) The Biological Environment, (3) The Social Environment, and (4) The Cultural Environment.

Other engineering schools offer period or type courses in English and in American literature, such as the Short Story, Modern Drama, etc. The United States Naval Academy offers a few elective courses appropriate to its general purpose, such as Naval History, and American Diplomacy. The Polytechnic Institute of Brooklyn has one with the title "Human Relations and the Integration of Character." Practical courses in business letters, report writing, thesis writing and public speaking are fairly common.

Through elective courses a school may set up a wide range of study; frequently the possibility of electives determines the nature and content of the required courses.

III. Courses That Are Supplemented in Unusual Ways

Several institutions separate their students at the outset of the college year into different levels and give them simultaneously some-

what different work. In some, two levels and in others, three levels are determined, usually by placement tests. One of the most carefully worked out plans is that at the University of Oregon, where three groups of entering students are formed. The highest level men are not required to take the work of the first term and the lowest level men are given sub-freshman work. The center of average group carries three terms of required English. Changes from one level to another may be made at the ends of terms if the circumstances warrant, but the course contents are distinct. Variations of this plan are used at Purdue University, Armour Institute of Technology, Louisiana Polytechnic Institute, and Georgia School of Technology. In some cases the lowest level students are given fundamental grammar drill without college credit; in other cases the review work is given full college credit. Problems of make-up work, repetition of course, and acceptance of credit often complicate not merely the office bookkeeping but also the actual accomplishments of the students.

Swarthmore College has met the difficulty by giving up all required courses. Both composition and literature are, of course, offered as electives. Any deficiency in writing in later terms is met by assignment to one of these elective courses in which creditable work must be done.

The Alabama Polytechnic Institute prescribes a tour of inspection of industries and business; the required writing is then based on the observations made on the trip. Union College has brought the use of a reflector lantern into the classroom, by means of which actual passages from student papers are thrown on a screen for analysis by the class as a whole. A number of schools, notably the University of Washington and the Iowa State College, coöperate with engineering departments in student written work, beyond the first year. In the latter institution the theme subjects are selected by the staff in electrical engineering, who insist upon accuracy in technical matters; the papers are then graded by the English staff for excellence in composition. Similar coöperation, but on a smaller scale and less systematically, is followed in several schools in the course in technical writing. Publication of excellent student papers is encouraged in some places, and if the school publishes a technical magazine (as distinct from a college newspaper), publication of student work is very commendable. Coöperation with some local engineering firms or even with city government departments has been carried out sporadically. There are fine possibilities in these ways to give reality to student work. Likewise in public speaking, students have been sent to groups such as society meetings, fraternal organizations, political rallies to speak about scientific or civic problems.

The inclusion of courses in modern languages is, perhaps, not a proper part of this survey, but all the possibilities are found, from the extreme of no modern language at all, at Stevens Institute, to the other extreme of as much as six credit hours, at Armour Institute of Technology, the Polytechnic Institute of Brooklyn, Clarkson College, the Carnegie Institute of Technology, and Rose Polytechnic Institute.

This chapter has presented interesting experiments in teaching English at engineering schools. The reasons for variations from normal courses have been discussed in brief. All this has been done in the hope that English courses may escape the criticism of being dull and that men in charge of English instruction may find ways to add new appeal to their most vital contributions to the engineering profession. The assumption of responsibility for training engineering students in effective writing is recognized by departments of English generally; they would not be willing to assume this responsibility alone, for everyone knows that teachers of engineering subjects can nullify much of the work of the English teachers, just as do certain home conditions and working environments. The spirit of coöperation on the part of teachers of English with the program and methods of engineering is also to be encouraged. The two groups of teachers can work together in carrying the high ideals of the engineering profession and the essential qualities of good citizenship to their students. The world of the engineer is large enough to include some of the humanities and the fine arts, and teachers of English can do much to make the prospective engineer conscious of the value of these fields and to prepare him to enjoy them.